SAWYER BROOK FLOOD PLAIN MANAGEMENT STUDY

CITY OF SACO
YORK COUNTY, MAINE

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York County Soil and Water Conservation District

Final Report
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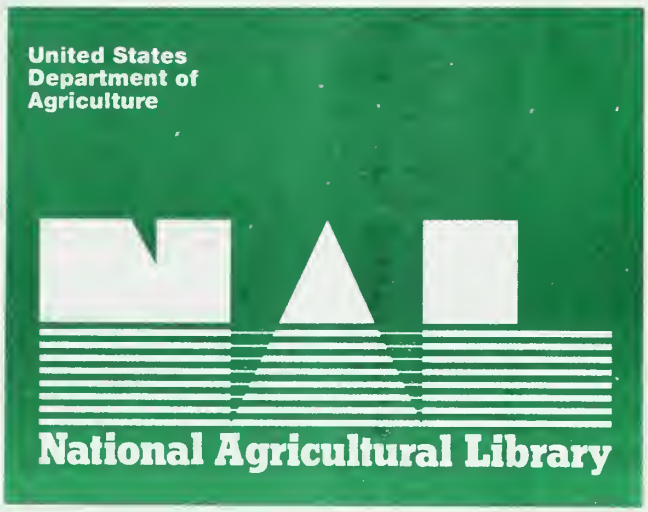

ACKNOWLEDGMENTS

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- City of Saco, ME
- DeLuca-Hoffman Associates, Inc. (DHAI), South Portland, ME
- Federal Emergency Management Agency (FEMA), Boston, MA
- Maine Department of Economic and Community Development (MDECD), Augusta, ME
- Maine Soil and Water Conservation Commission (MSWCC), Augusta, ME
- National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), Asheville, NC
- United States Fish and Wildlife Service (USFWS), Old Town, ME
- United States Geological Survey (USGS), Augusta, ME
- York County Soil and Water Conservation District (YCSWCD), Sanford, ME

TABLE OF CONTENTS

Appendices

SAWYER BROOK
FLOOD PLAIN MANAGEMENT STUDY
CITY OF SACO, YORK COUNTY, MAINE

INTRODUCTION

This Flood Plain Management Study (FPMS) report presents 100-year flood plain information for the Sawyer Brook channel within the City of Saco, Maine. Data generated consists of a flood hazard evaluation, including flood plain maps and flood profiles, and options for flood plain management.

Participants shared technical information and recommendations contained in this report as they became available. The City should continue to use the data and recommendations to reduce nuisance flooding and high water table problems; as a guide for implementing a flood plain management program for the watershed and the remainder of the City; to revise and enforce City codes and ordinances; and to complement the ongoing combined sewer overflow (CSO) abatement effort. The data generated by this study should be useful to local, state, and Federal agencies, planning groups, engineers, consultants, and others involved in community planning and the design of hydraulic structures, conduits, channels, roads, bridges, culverts, and other community facilities.

The report also provides information needed to comply with Maine's 'Mandatory Zoning and Subdivision Control Law,' which applies to shoreland areas. Such regulations are needed to minimize loss of life and property damage from future floods, prevent degradation of the watershed's environmental resources, and ensure orderly community growth in areas suitable for development.

NRCS conducted this study in response to a request by the City of Saco to the York County Soil and Water Conservation District (YCSWCD) following hurricane 'Bob' in August 1991. The City submitted a formal application for Federal assistance in developing an FPMS to the Maine Soil and Water Conservation Commission (MSWCC), which establishes water resource study priorities throughout Maine under a Joint Coordination Agreement with NRCS.

NRCS carries out these studies under provisions of Section 6 of Public Law 83-566, the Watershed Protection and Flood Prevention Act of 1954, as amended. It received authorization on October 2, 1992, at the beginning of Federal fiscal year 1993, to begin the study. Participants cooperated in developing a Draft Plan of Work (POW) dated July 1993. The revised Final POW was signed on February 1, 1994. NRCS circulated the draft FPMS for review on October 23, 1995. All comments, suggestions, and recommendations from the review were considered in preparation of this final report.

STUDY AREA

The study area is the entire 241 acre watershed of Sawyer Brook within the City of Saco, a small, coastal community in York County, southwestern Maine. It is on the Saco River and Atlantic Ocean about 12 miles southwest of Portland and about 90 miles northeast of Boston, MA (see **Figure 1**).

Setting

This section provides a summary of the watershed and its physical, natural, cultural, and social resources. The region's economy is tied closely to tourism, recreation, and manufacturing.

Watershed Delineation - Based upon land use, topography, and surface and subsurface drainage patterns, DHAI divided the Sawyer Brook watershed into 25 subwatersheds designated A through Y and ranging in size from 0.8 to 35 acres. **Figure 1** also delineates subwatersheds G, H, and X (inclusively) and subwatershed Y. Study participants used these 25 subwatersheds as delineated on the 2 foot contour interval, 1" = 100' base maps provided by DHAI. The hydrologic unit code for this watershed is 01060002-190 **(USDA, SCS, 1982.)**

Sawyer Brook - Sawyer Brook is a small and insignificant, but direct, tributary of the Saco River. It flows in a generally southerly direction and joins the river about 5 miles upstream of the river's mouth at the Atlantic Ocean. The brook, which historically began as a perennial stream just above the present location of Therrien Avenue, flows mostly in an open channel for about 3,000 feet before entering an approximately half-mile long culvert at Sawyer Street in downtown Saco. This culvert is severely undersized and a major constriction to runoff from even minor storms. Study participants know little about its condition.

There are six additional culverts on the main stem of Sawyer Brook. These are at Spring Street, Nye Street, Park Street, the Boston & Maine Railroad, North and Roebuck Streets, and Therrien Avenue. Street names are shown on the Flood Plain Maps, **Appendix A**. A tributary, entering Sawyer Brook from the west, has an additional three culverts, located at Park Street, the Boston & Maine Railroad, and Franklin Street. There are no dams on Sawyer Brook or its tributaries.

Combined Sewer Overflows (CSO) -- The City contains 23 sewer service areas (SSA) or districts (geographic areas). All or parts of 11 SSA's fall within the Sawyer Brook watershed. Approximately 70 acres of the lower part of the watershed are tributary to the City's combined sewer system.

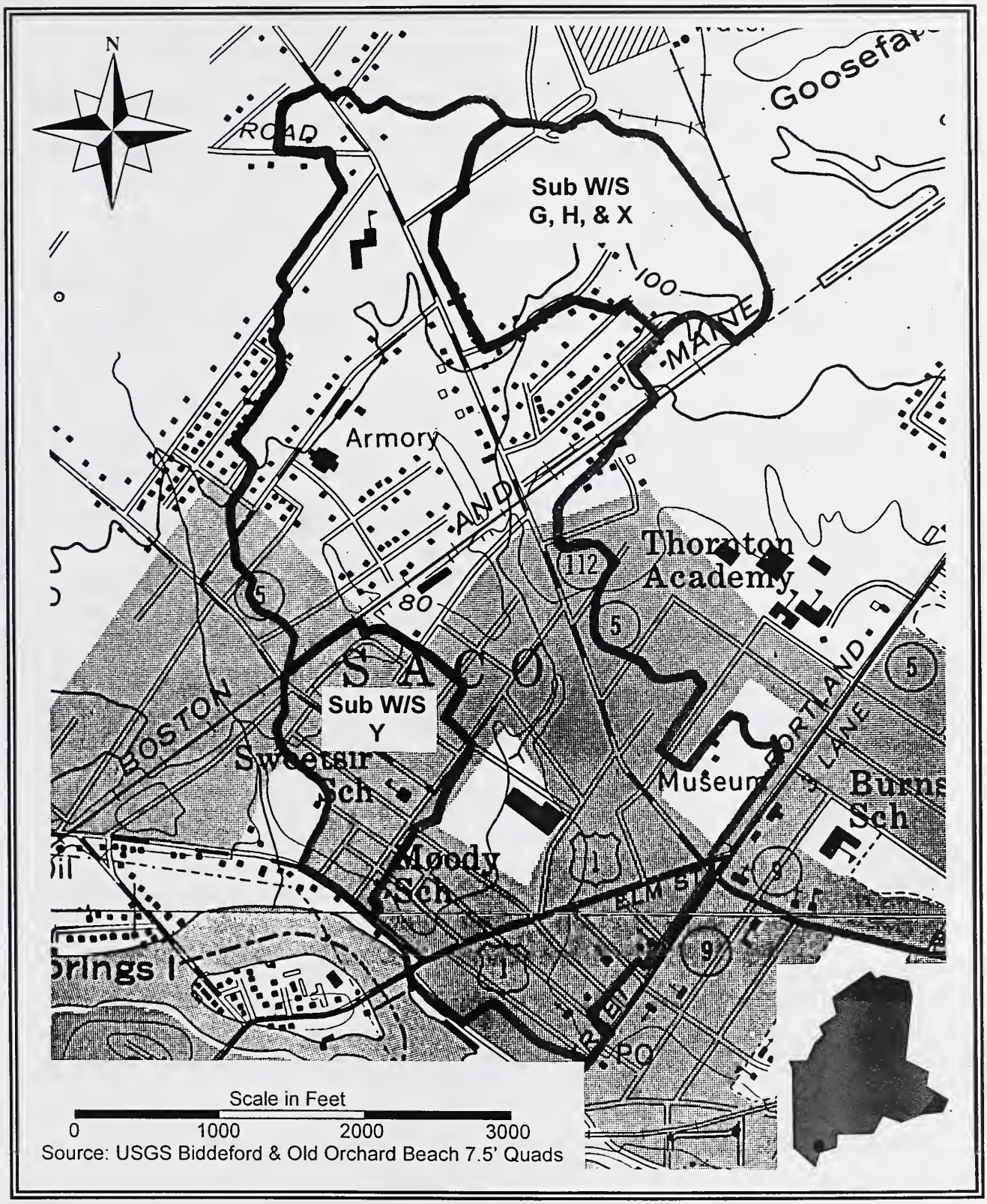
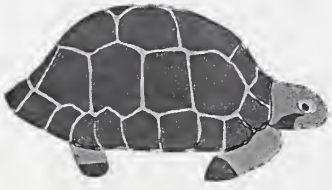


Figure 1 -- Location and Study Area Map
Sawyer Brook Watershed, Saco, Maine

The Draft CSO Master Plan indicates that there are nine CSO's in the City. Three are physically located within the Sawyer Brook watershed, but only two overflow into Sawyer Brook -- CSO#1 at Elm Street and CSO#8 at Spring Street. CSO#7 overflows directly to the Saco River at Water Street. These three CSO's function fewer than three times a year, less than the four events allowed under the Environmental Protection Agency's (EPA) 'presumptive' approach. However, the combined sewers within the watershed also contribute to CSO#4, outside the watershed at Front Street, which functions about 31 times per year **(DHAI, 1994.)** Abatement of CSO's to prevent degradation of water quality in receiving waters, Sawyer Brook and the Saco River, and to prevent violations of state and Federal water quality standards will require separation of a significant part of the combined sewer areas of the watershed. Much of this separation is not possible until an adequate outlet to the Saco River exists for Sawyer Brook.

Wetlands - The U.S. Fish and Wildlife Service (USFWS) inventoried the area's wetlands and published wetland maps (see **Figure 2**) as part of the National Wetland Inventory (NWI) **(USDI, FWS, 1994.)** NRCS personnel visited the few small wetlands identified in the NWI and verified that they exist and that their boundaries appear accurate at a map scale of 1:24,000. These are palustrine, forested, broad-leaved deciduous or narrow-leaved evergreen wetlands that are seasonally flooded or saturated. Some are natural, while others are man-made. There are no great ponds (surface area 10 acres or greater) in the Sawyer Brook watershed.

Wetlands can retard runoff and provide significant treatment of water detained in them. However, the watershed's NWI wetlands are too high up in the watershed and too small to provide any significant level of either flood protection to damaged areas downstream or treatment beneficial to water quality.



Small wetlands generally support typical wetland species. However, the USFWS reported that at least two species of turtles, listed on the State of Maine threatened and endangered species list, are known to live in small wetlands in the Saco-Biddeford area.

The NWI intentionally does not attempt to define the limits of the jurisdictional wetlands of any Federal, state, or local agency. Persons intending to alter any area within or near any possible or suspected jurisdictional wetland area should seek the advice of the regulatory authority concerning the level of investigation necessary to satisfy permitting requirements.

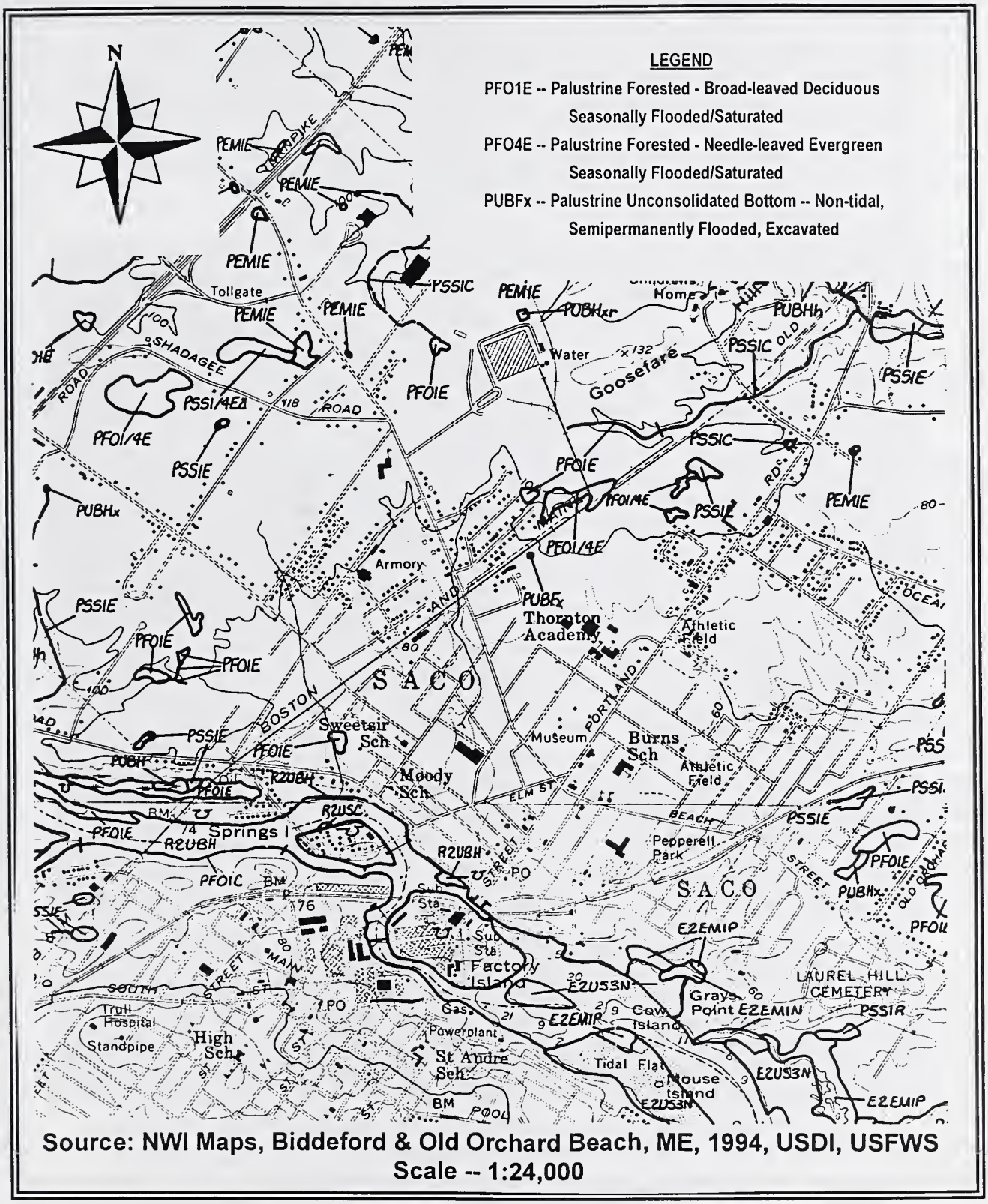


Figure 2 -- National Wetlands Inventory (NWI) Map
Sawyer Brook Watershed, Saco, Maine

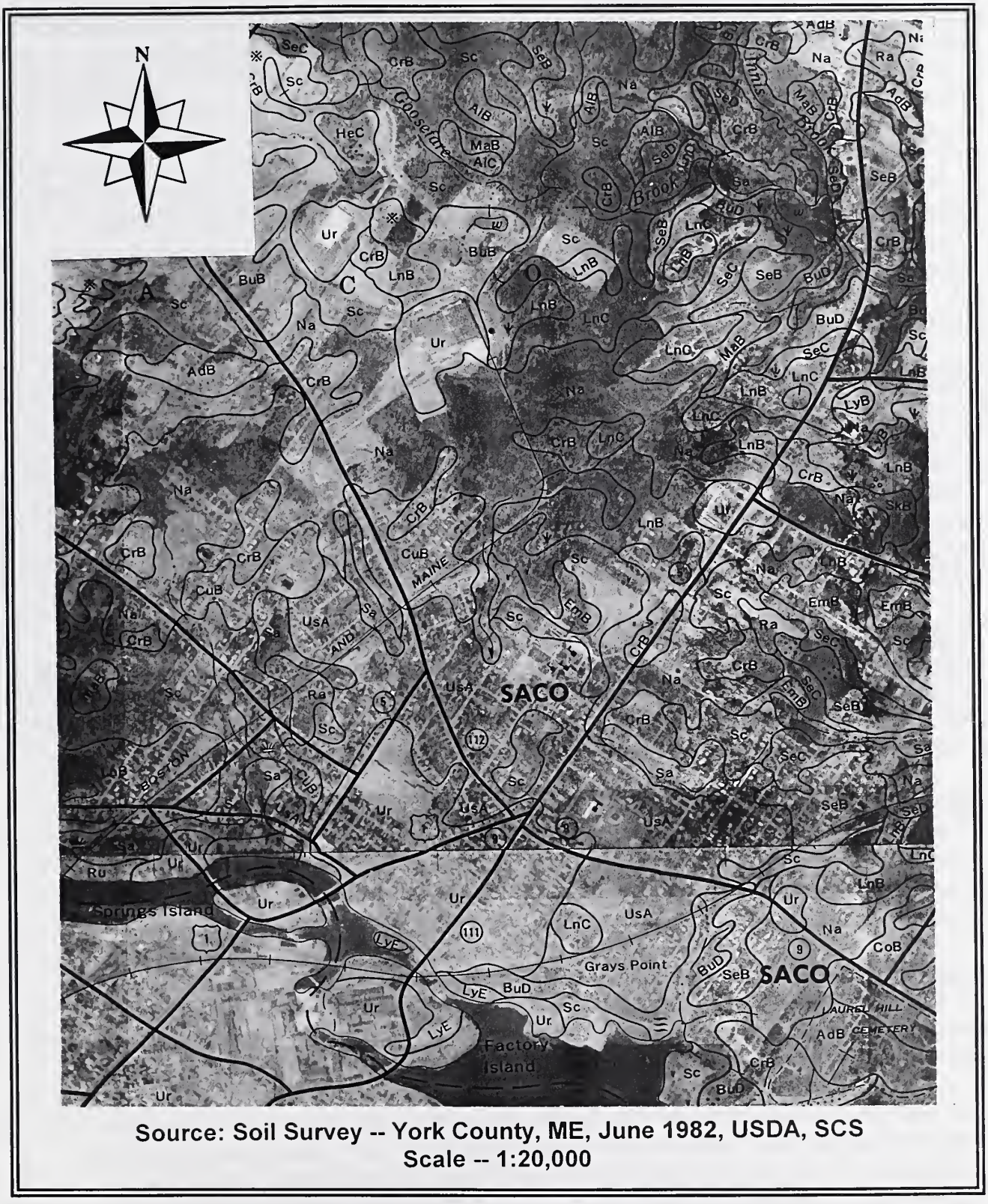
Geology - Stratified metasedimentary rocks underlie the watershed. The Cape Elizabeth formation of the Merrimack group underlies the northern part of the watershed, and the Berwick formation of the Casco Bay group underlies the southern part. An ancient, pre-metamorphic thrust fault that trends in an east-west direction separates the two formations **(Hussey and Pankiwskyj, 1976.)** The watershed's bedrock is not a source of building or dimension stone, base metals, pegmatite minerals, or other mineral resources **(Rand, I957; MDED, MGS, 1959.)**

Most of the watershed's surficial materials are fine-grained glaciomarine sediment that accumulated on the ocean floor about 11,000 to 13,000 years ago. During deglaciation sea level was a few hundred feet higher than it is now. Sandy textures are dominant but some siltier deposits are present. Small, low-relief moraines that trend generally in an east-west direction contain till. The Saco River flood plain contains alluvium. The Maine Critical Areas Program does not list any significant geologic localities within the watershed **(Hussey, 1978** and **Hussey, 1977.)**

Soils - NRCS developed all soils information used in this study, including soil maps, hydrologic soil groups, and hydric soil indicators. The soils map (see **Figure 3**) is from the medium intensity Soil Survey of York County, Maine, mapped at a scale of 1:20,000 **(USDA, SCS, June 1982.)** National Cooperative Soil Survey map accuracy standards for this scale allow inclusions of other soils of up to 4 acres in size. The computerized State Soil Survey Database (SSSD) was the source of interpretive data. NRCS provided computer files of digitized versions of these soils maps and their data attributes to DHAI for their use in project evaluation.

Saco is a very poorly drained flood plain soil. Croghan and Naumburg soils developed on sandy glaciomarine sediments and outwash. Scantic soil developed on silty glaciomarine sediment. Lyman is a thin, glacial till soil underlain by bedrock. Soil mapping units meeting hydric ('wet') soil criteria (see **Glossary** for definition) occur on approximately 60 percent of the watershed and soil mapping units containing inclusions of hydric soil occur on the remaining 40 percent. There are no nonhydric soil mapping units in the watershed.

At the City's request, NRCS soil specialists verified soil mapping unit boundaries in the northeastern part of the watershed, where additional commercial-industrial development is likely within subwatersheds G, H, and X and adjacent areas outside the Sawyer Brook watershed. The field verification of the published soils map indicated that soils were mapped correctly. Only a very narrow, 100 foot wide band of Croghan soil, too small to delineate at the mapping scale, exists in this area mapped as Naumburg soil. The areas mapped and verified as nonhydric soils have a seasonal high water table at or very near the surface, even though they do not exhibit every characteristic required to meet hydric soil criteria.



Source: Soil Survey -- York County, ME, June 1982, USDA, SCS
Scale -- 1:20,000

Figure 3 -- Published Soils Map
Sawyer Brook Watershed, Saco, Maine

Ground Water - The entire upper half of the watershed (120 acres) falls within a small part of a large, contiguous sand and gravel aquifer. The Maine Geological Survey mapped the area as a 'Significant Sand and Gravel Aquifer' **(Tolman & Lanctot, 1985.)** It is favorable for the development of ground water supplies that can yield from 10 and 50 gallons per minute of water to wells. The normal water tables in this aquifer often are higher than basement floor elevations. Soil maps and interpretive data indicate that seasonal high water tables in the entire watershed lie between the surface and a 2-foot depth for over 6 months a year on all but Lyman soils. Residents indicate that wet basements are a widespread problem in the watershed (see **Flood History - Damage Surveys**).

Fish - Sawyer Brook no longer has any fishery value.

Wildlife - The few forested and idle land areas in the upper part of the watershed provide habitat suitable for many common game and non-game species of upland wildlife that adapt readily to an urban influence. These species include squirrel, chipmunk, deer, woodchuck, skunk, raccoon, fox, coyote, porcupine, rabbit, and hare. Smaller mammals such as rats and mice, voles and moles, bats, and shrews live throughout the watershed. Bird, reptile, and amphibian species are typical of the general area, except for the turtles mentioned in the discussion of wetlands **(USDA, USFS, 1986.)**

Cultural Resources - The coastal zone of southern Maine, particularly near major rivers, is known to be rich in cultural (archeological and historical) resources, particularly Paleo-Indian resources. Europeans first settled areas of Saco in 1623, so the City has a long and diverse historic past. Any proposed ground-disturbing activity would require an on-site investigation to determine the potential effect upon those resources.

Climate - The area's mean annual precipitation is 45 inches, which includes the water equivalent of 79 inches of snow. The precipitation occurs evenly throughout the year; however, snowmelt accounts for a large part of the runoff. The mean annual temperature is 48.0 degrees Fahrenheit (^{O}F). Monthly mean temperatures range from a low of 24.1^{O}F in January to a high of 71.7^{O}F in July **(USDA, NRCS, 1995.)**

Land Use - NRCS used several sources to determine the present land use, including: the DHAI base maps, aerial photographs, USGS land use and cover maps, USGS 7.5' topographic maps, and visual watershed surveys. Major land uses are urban, urban-residential, forest land, and commercial-industrial.

The watershed is approximately two-thirds developed, with mixed commercial and urban-residential uses prevailing in the downstream part and residential uses in the central part. The more highly forested upper third of the watershed is receiving development pressure, and several industrial complexes lie on the northeastern watershed boundary.

Existing uses of the little remaining undeveloped land are primarily educational or recreational in nature and may include activities such as play (by children), nature photography and study, biking, walking, cross-country skiing, ATV riding, and snowmobiling.

Demand for land for development has increased in recent years, which has resulted in construction in areas poorly suited for residential and commercial buildings. New construction still is taking place in most parts of the watershed.

Population - The resident population of Saco increased from 12,921 in 1980 to 15,181 in 1990. The part-time population varies throughout the year and increases significantly during peak tourist periods when people visit the area's sand beaches. Of the 105 persons that are non-white, 33 are black and 72 are Asian and Pacific Islanders. Seventy persons are Hispanic. The most commonly-reported ancestries, in decreasing order, are French, English, French Canadian, Irish, German, Scottish, and American.

About 52.2 percent of the population is female; 13.2 percent is 65 years of age or older; and 26.6 percent is under 20 years of age.

Median and average 1989 household incomes were $32,655 and $36,209. Some 6.1 percent of the population is below poverty level. The median value of owner-occupied housing units was $113,200.

Transportation - Highway access is by State Routes 5, 9, 98, and 112; US Route 1; and Interstates 95 (Maine Turnpike) and 195. The Boston & Maine Railroad serves Saco. There is no airfield or commercial seaport in Saco.

" The three major factors in flooding are rain, rain, and more rain."

When the Rivers Rise, Maine Emergency Management Agency, 1993.

Flood History

Sawyer Brook's flood history indicates that damages can occur at any time during the year, but particularly in the winter and early spring months following heavy rainfall on snow-covered or frozen ground; in summer following intense thunderstorms; and in summer and fall during tropical hurricanes. The most recent serious flooding occurred in August 1991 during hurricane 'Bob.' This storm had an estimated recurrence interval of more than 100 years. Several roads, culverts, and conduits in this watershed overtop even during smaller storms. The City uses the 25-year storm as a standard for design of its hydraulic structures.

Figure 4, FEMA's Flood Insurance Rate Map (FIRM) for Saco, shows the extent of the 100- and approximate 500-year flood plains in the lower reaches of the watershed **(FEMA, 1983.)** The elevation of the extensive 500-year flood zone (light gray) in the downtown area is about 59.6 feet NGVD. This zone extends up the historic Sawyer Brook flood plain to beyond the Saco Valley Shopping Center, and down the Saco River nearly to Main Street. It was flooded severely during hurricane 'Bob'. The narrow 100-year flood zone (dark gray) above Springs Dam is at about elevation 57.2 feet NGVD.

Damage Survey - To obtain information on the extent of present problems, the City of Saco mailed a flood damage survey questionnaire to all watershed property owners whom city employees and officials believed suffered damages during hurricane 'Bob.' The originals of all response forms are on file with the Saco Public Works Department.

The survey asked for specific information on past flooding events at the address. Of the 159 surveys that watershed respondents returned, 78 reported that water never damaged their property. Eighty-one respondents reported having received water damage at least once. Damage caused by hurricane 'Bob' and other storms was to single- and multi-family residences, businesses, yards, and roads. Stream bank erosion typically was not a problem because gradients are flat and velocities are low.

The City and DHAI believe the high level of cooperation shown by residents and the nature of their survey responses attests to a consensus that the drainage problems in the Sawyer Brook watershed are significant. Merchants in the Saco Valley Shopping Center and residents in the many other areas of the watershed continue to express concern with deficiencies in the drainage system.

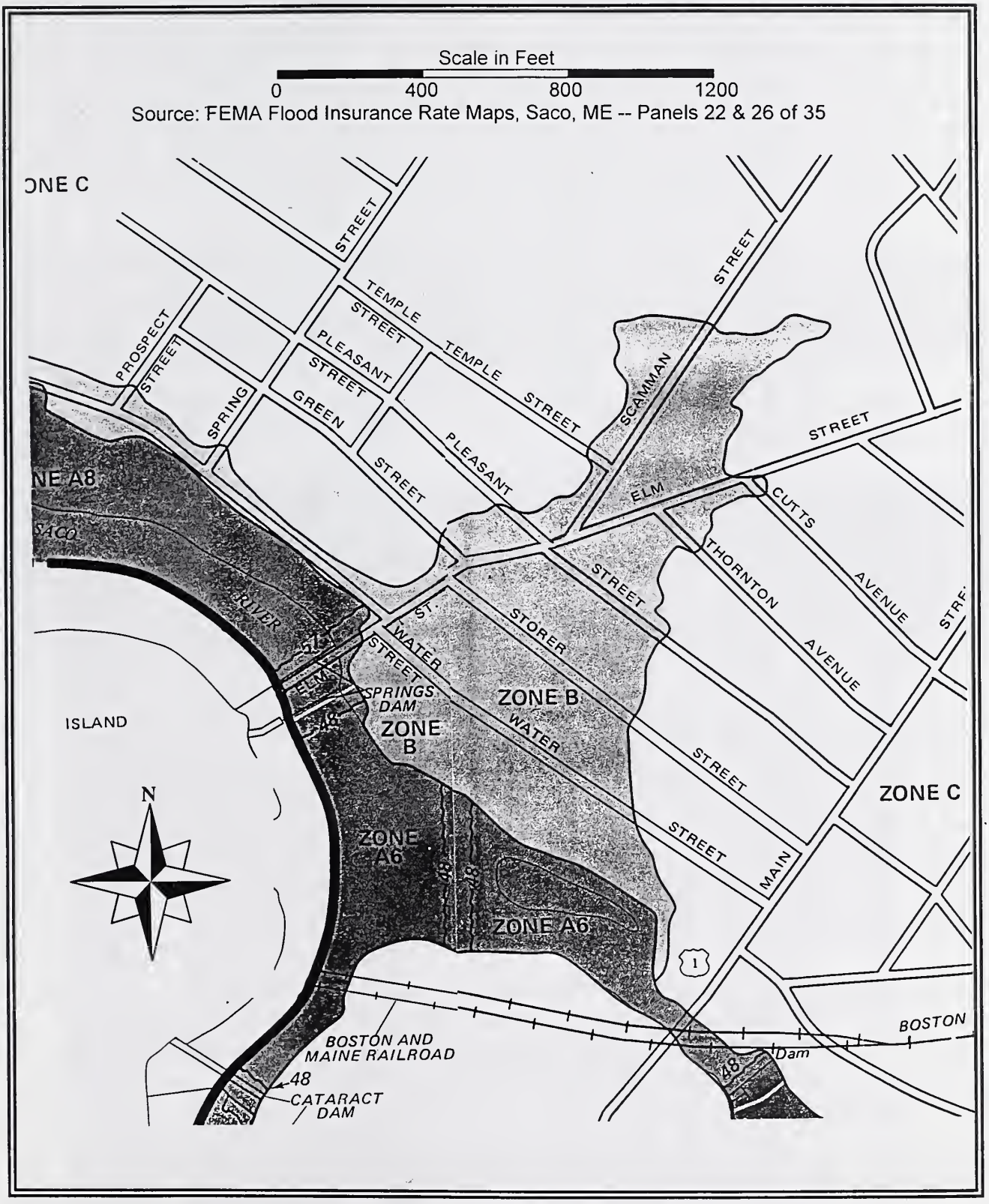


Figure 4 -- Flood Insurance Rate Map
Sawyer Brook Watershed, Saco, Maine

Table 1 indicates the location of damage and source of water for the 81 damaged properties. Only four respondents (two businesses and two apartment complexes) reported first floor water damages. One business reported being flooded by out-of-bank flow; the 1936 Saco River flood damaged it most severely. Floods damaged the other business several times, most severely during hurricane 'Bob.' It floods primarily because the building itself extends completely across the natural flood plain and acts as a dam, ponding overland flow upstream of the building to a depth of 5 to 6 feet before water enters the building through rear entrances.

TABLE 1 -- LOCATION OF DAMAGE AND SOURCE OF WATER TO 81 DAMAGED PROPERTIES SAWYER BROOK WATERSHED, SACO, MAINE

LOCATION OF DAMAGE	SOURCE OF WATER					TOTALS
	NOT KNOWN	GROUND WATER	OUT-OF-BANK FLOW	OVERLAND FLOW	SEWER BACKUP	
BASEMENT	23	22	1	2	12	60
FIRST FLOOR	0	1	1	1	1	4
YARD	0	0	4	7	0	11
UNKNOWN	4	0	1	0	0	5
ROADS	0	0	0	1	0	1
TOTALS	27	23	7	11	13	81

These tables summarize actual survey responses. It seems likely that all those responding that the source of water in their basement was 'Not known,' actually were damaged by ground water (a high water table). Most property owners would know if water in their yard was deep enough to enter the building through a low opening such as a basement window, door, or vent. Likewise, property owners would know if sewer backups damaged their basements, as sewage is readily distinguishable from ground water. They are quite dissimilar in appearance, odor, and the residue they leave behind. It is probable that ground water, not sewer backup, overland flow, or out-of-bank flow, damaged over 75 percent of the buildings (49 of 64).

An apartment building near the Saco River had its basement filled to the first floor because of a sewer backup during the spring of 1989 or 1990. Another apartment complex, built on the sand and gravel aquifer where the ground water table is high, responded that this condition causes moisture problems throughout the several buildings in the complex.

Not one of 159 respondents reported receiving first floor water damage caused by the open Sawyer Brook channel.

Table 2, Damage Survey Summary, tabulates all responses that reported any water damage. The table omits street addresses on purpose.

TABLE 2 -- DAMAGE SURVEY SUMMARY
SAWYER BROOK WATERSHED, SACO, MAINE

HOUSE NUMBER	STREET	SUB-WATERSHED	DATE OF MOST DAMAGE	$ DAMAGE	SOURCE OF WATER	WATER DEPTH (FT)	WATER LOCATION	SOIL MAPPING UNIT	YEARS OCCUPIED	TIMES DAMAGED	1ST FLOOR DAMAGE	REMARKS
	Bonython	I	80 – 85?	0	Not Known	2.5	Basement	CuB	17	2	No	One foot of water in road
	Bonython	W	?	0	Sewer Backup	2.0	Basement	CuB	21	?	No	
	Bonython	I, W	Spring	0	Overland Flow	2.0	Grounds Only	CuB	23	23	No	Backyard floods
	Bonython	H	?	100	Ground Water	0.04	Basement	CuB	2	15	No	
	Bonython	W, X	Every spring	3,500 total	Overland Flow	0.5	Basement	CuB	34	34	No	Constructing and raising road aggravated problem; 0.5 feet of water on lawn and driveway
	Bonython	X	N/A	0	Overland Flow	?	Lot Only	CuB	34	?	N/A	Drainageways at Themen were filled with new homes; need storm drain
	Bonython	H	N/A	0	Overland Flow	?	Grounds Only	CuB	0.5	0	No	Waded in street to take child to school
	Bonython	X	N/A	0	Overland Flow	?	Lot Only	CuB	34	?	N/A	Extension of Themen Ave. and new home construction filled drainageways; storm drain needed
	Central	C	8/19/91	275	Not Known	2.5	Basement	UsA	22	1	No	One foot of water in backyard
	Central	C	Summer 89 & 91	500	Not Known	3.5	Basement	UsA	6	2	No	Five feet of water in backyard; water on sidewalk with almost every rain
	Central	C	8/91	1,500	Ground Water	5.0	Basement	UsA	7	Many	No	Backyard filled several times a year; Installed own storm drain
	Central	C	?	3,000	Sewer Backup	2.0	Basement	UsA	8	3	No	Basement has finished apartment
	Central	C	8/91	1,000	Ground Water	3.0	Basement	UsA	5	Many	No	Three feet of water in backyard
	Central	C	N/A	0	Overland Flow	?	Grounds Only	UsA	2	0	No	Gravel from abutter parking lot plugging storm drain
	Elm	O	N/A	0	Ground Water	?	Basement	Ur	22	0	No	Ground water high in spring and dunng rains
	Elm	R	1936 & 1953 Saco River	?	Out-of-bank Flow	1.0 - 2.0	First Floor	Ur	70	2	Yes	Four feet of water at intersection Water & Elm; 5 feet of water in basement
	Elm	R	Spring 87 & 90	0	Ground Water	1.0 - 2.0	Basement	Ur	18	2	No	Water table at river level
	Elm	R	?	?	Not Known	2.0	Not Reported	Ur	0.8	0	?	Evidence of 2 feet of water in structure at some time in the past
	Elm	O	1991	200	Not Known	2.0	Basement	Ur	7	1	No	
	Franklin	F	89, 91, 92, 93	500	Ground Water	0.5	Basement	CuB	60	Many	?	Also flooded by large Saco River floods
	Jordan	W	Winter & Spring	?	Ground Water	0.5	Basement	CuB	1.5	6	No	One-half foot of water at edge of driveway
	Jordan	W	?	?	Ground Water	?	Basement	CuB	23	?	No	Water in basement dunng bad rains and when brook is full
	Jordan	I	?	0	Ground Water	0.04	Basement	CuB	16	?	No	
	Mechanic	L	?	?	Sewer Backup	?	Basement	UsA	6	Many	No	Sewer backup three or four times in 1993, and several other times
	Mechanic	L	?	5,000	Not Known	2.0	Basement	UsA	20	8	No	Auto damaged outside; 4 feet of water in backyard

TABLE 2 -- DAMAGE SURVEY SUMMARY (Cont'd)
SAWYER BROOK WATERSHED, SACO, MAINE

HOUSE NUMBER	STREET	SUB-WATERSHED	DATE OF MOST DAMAGE	$ DAMAGE	SOURCE OF WATER	WATER DEPTH (FT)	WATER LOCATION	SOIL MAPPING UNIT	YEARS OCCUPIED	TIMES DAMAGED	1ST FLOOR DAMAGE	REMARKS
	North	L, N	?	0	Not Known	0.2	Basement	Ur	18	Many	No	
	North	L, N	8/91	?	Not Known	0.7	Basement	UsA	24	Many	No	
	North	L, N	?	0	Not Known	0.5	Basement	UsA	3	?	No	
	North	L	?	0	Out-of-channel Flow	?	Grounds Only	UsA	32	?	No	Backyard floods, aggravated by new construction; Sawyer Brook smells
	North	L	?	0	Out-of-bank Flow	3.5	Grounds Only	UsA	14	4	No	Lawn floods to 3.5 foot depth
	North	J	8/91	0	Not Known	1.0	Basement	CuB	2	1	No	
	North	F	Spring	0	Not Known	0.1	Basement	CuB	1.5	1	No	
	North	I	?	?	Out-of-bank Flow	?	Basement	CuB	40	Several	No	Water entered through back door
	North	I	?	0	Out-of-bank Flow	1.0	Grounds Only	CuB	13	5 or 6	No	Backyard floods
	North	H, J	?	?	?	?	?	CuB	44	1	?	
	Nye	C, Y	?	0	Sewer Backup	0.3	Basement	UsA	10	2	No	Drainage ditch to Spring Street sewer not working properly
	Nye	C	?	?	Sewer Backup	3.0	Basement	UsA	26	6 or 7	No	
	Nye	C	8/91	600	Not Known	2.0	Basement	UsA	12.5	2	No	Flooded 11/90 also
	Oak	B	?	?	Not Known	1.0	Basement	UsA	12	3	No	Need more drainage
	Park	C, K	1990?	?	Sewer Backup	?	Basement	UsA (&Sa)	?	1	No	Basement carpet damaged
	Park	C	91 & 92	0	Overland Flow	3.0 - 4.0	Road	UsA	26	?	No	
	Pepperell	B	N/A	0	N/A	?	N/A	Na	30	0	No	"Where is Sawyer Brook?"
	Pepperell	B	8/91	?	Ground Water	0.5	Basement	UsA	11.5	2	No	Finished basement; 1 1/2 foot flooding in backyard two or three times annually; condo construction caused problem
	Pepperell	B	?	3,000	Not Known	4.0	Basement	UsA	20	Annually	No	One to 2 feet of water in road and driveway
	Pepperell	F	N/A	0	N/A	?	?	UsA	35	0	No	Railroad culvert plugged
	Pleasant	R	?	250	Ground Water	1.0	Basement	Ur	40	Many	No	Water in basement every heavy rain
	Pleasant	O	?	100	Sewer Backup	3.0	Basement	Ur	23	Annually	No	One foot of water at rear basement entrance
	Roebuck	W	1991	?	Not Known	?	?	CuB	37	1	?	
	Roebuck	W	Fall 1992	?	Not Known	1.0	Basement	Na (&CuB)	30	1	No	
	Saco Valley Shopping Center	M	8/91	250,000	Overland Flow	2.0	First Floor	Ur	28	4	Yes	Adjacent stores had minimal damage; 5 feet of water at rear of building
	Sawyer	L	3/13/76	8,000	Not Known	6.5	Basement	UsA	19	7	No	Water 4.0 feet deep in road; foundation caved in in 1976

TABLE 2 -- DAMAGE SURVEY SUMMARY (Cont'd)
SAWYER BROOK WATERSHED, SACO, MAINE

HOUSE NUMBER	STREET	SUB-WATERSHED	DATE OF MOST DAMAGE	$ DAMAGE	SOURCE OF WATER	WATER DEPTH (FT)	WATER LOCATION	SOIL MAPPING UNIT	YEARS OCCUPIED	TIMES DAMAGED	1ST FLOOR DAMAGE	REMARKS
	Spring	C, Y	8/91	?	Not Known	2.0	Not Reported	Ur	?	1	?	Likely basement flooding
	Spring	C	?	500	Sewer Backup	3.0	Basement	Ur	30	5	No	One foot of water on street
	Spring	C	?	700	Not Known	3.0	Basement	Ur	30	3	No	Water 1 1/2 feet deep at driveway
	Spring	C	8/91	?	Not Known	0.8	Basement	Ur	2.75	1	No	Water 1/2 feet deep at road
	Spring	C	?	?	Ground Water & Sewer Backup	0.5	Basement	Ur	21	Many	No	Rent large pump every big rain, in addition to own two pumps; heavy runoff from Nye Street
	Spring	C	8/91	1,000	Sewer Backup	3.0	Basement	Ur	8	2	No	One foot of water in driveway; storm drain removal aggravated problem
	Spring	C, L	Fall 1991	100	Not Known	4.0	Basement	UsA	7	2	No	Water 1.5 feet deep at intersection
	Spring	C, L	2/91	0	Not Known	0.7	Basement	UsA	30	1	No	
	Spring	C	8/91	320	Not Known	2.5	Basement	UsA	31	2	No	Water 1.0 foot deep in backyard
	Spring	C, L	?	0	Not Known	0.7	Basement	UsA	?	Annually	No	
	Spring	C, L	?	0	Not Known	0.7	Basement	UsA	?	Annually	No	
	Spring	L	?	?	Out-of-bank Flow	6.0 - 8.0	Grounds Only	UsA	2	?	No	Backyard eroding
	Spring	C, K	N/A	?	Out-of-bank Flow	?	?	UsA	7	0	No	Sewer pipe uncovered and damaged during high water
	Stacy	B	?	?	Ground Water	1.0	Basement	Sa	1.75	2	No	Basement would flood one or two times a year without a sump pump
	Stacy	B	?	500	Ground Water	0.5	Basement	Sa	4.5	4	No	Water 1 foot deep around foundation; no outlet drain for street water, which enters yard
	Storer	R	89 & 8/91	2,500	Sewer Backup	4.0	Basement	Ur	12	3 or 4	No	One to 2 feet of water outside
	Themien	H	8/91	200	Ground Water	3.0	Basement	CuB	5	Annually	No	Water 3 feet deep north of house
	Themien	I	8/91	'Thousands'	Ground Water	5.0 - 6.0	Basement	CuB	40	35	No	Water 1 to 2 feet deep outside
	Themien	H	?	?	Ground Water	N/A	First Floor	Na (&CrB)	11	Ongoing	No	Moisture problems in apartments
	Themien	I	?	?	Ground Water	1.1	Basement	CrB	15	6	No	Water 2 to 3 feet deep in road
	Themien	I	?	500	Ground Water	0.1	Basement	CrB	25	Many	No	One inch of water in basement without sump pump, problem aggravated by new home construction
	Themien	I	8/91	1,000	Ground Water	0.3	Basement	Na	20 +	Annually	No	Water 0.3 feet deep in street
	Themien	H, I	N/A	0	Overland Flow	?	Grounds Only	Na	4.5	0	No	Water in yard after heavy rain
	Themien	H	8/91	3,000	Sewer Backup	0.7	Basement	Na	25	75	No	Water 1 foot deep in yard and drive
	Themien	H	8/91	7,000	Ground Water	2.0 - 3.0	Basement	Na	22	20 - 30	No	All surface drains filled years ago; storm drains inadequate; basement destroyed three times
	Themien	H	8/91	?	Ground Water	1.0	Basement	Na	22	6 +	No	Water 1 to 2 feet deep outside
	Themien	H, G	?	?	Overland Flow	0.7	Basement	Na	23	3	No	Finished basement apartment; garage floods; water 0.7 feet deep in yard

TABLE 2 -- DAMAGE SURVEY SUMMARY (Cont'd)
SAWYER BROOK WATERSHED, SACO, MAINE

HOUSE NUMBER	STREET	SUB-WATERSHED	DATE OF MOST DAMAGE	$ DAMAGE	SOURCE OF WATER	WATER DEPTH (FT)	WATER LOCATION	SOIL MAPPING UNIT	YEARS OCCUPIED	TIMES DAMAGED	1ST FLOOR DAMAGE	REMARKS
	Thornton	Q	?	360	Ground Water	2.5	Basement	Ur	21	4	No	All flooding in last 5 years, basement floods during heavy rains
	Village Green	D	8/93	2,000	Not Known	0.5	Basement	Na	0.5	1	No	Water 1 foot deep in front of house
	Village Green	D	?	0	Overland Flow	?	Grounds Only	Na	7	Many	No	Backyard floods in spring and summer; no basement
	Water	N/A	Spring 1989	50,000	Sewer Backup	9.0	Basement to First Floor	Ur	7	2	Yes	Turned in two surveys that do not agree; 1 foot of water in parking lot
	Water	R	1986 or 1987	4,000	Sewer Backup	?	Basement	Ur	15	1	No	Problem only when Saco River floods

" It has been said that the best way to build a basement in a flood plain is -- DON'T. "

Flood Emergency and Residential Repair Handbook, FIA-13, FEMA, 1986.

Monetary Damages - **Table 3** indicates the extent of monetary damages at all damaged properties. Many respondents reported actual dollar damage. Damage to other properties was estimated based on the average damage to the category. Because the City conducted the survey in 1993, NRCS updated damage figures to 1995 dollars using the Consumer Price Index (CPI.) The 1993 CPI was 435.4, and the estimated 1995 CPI is 455.0. This increases the damage values by just over 4.5 percent.

Since no respondents reported first floor flooding from the open channel of Sawyer Brook, NRCS had no data to justify or support the conduct of either an urban damage or a high hazard flood area analysis. Surveys indicate that out-of-bank flooding from the open Sawyer Brook channel is not a significant problem.

Average Annual Damages - In a 'worst-case' damage scenario, assume that all reported damage was caused by out-of-bank flow during a 100-year storm (hurricane 'Bob' was closer to a 500-year storm), and that damage begins between a 5- and 15-year event (one key property has been flooded three or four times since 1965, or roughly once every 7 to 10 years.) Using standard damage-frequency curves, the average annual damage would equal 6.4 percent of the 100-year damage of $388,126 or $24,840.

Considering only those survey responses that indicated their worst damage was a result of hurricane 'Bob,' total damages from a 100-year storm were $288,283 when indexed to 1995 dollars. The average annual damage would be $18,450.

However, after hurricane 'Bob,' the key property constructed a new storm drain to reduce flood damages. If it reduces stages enough to avoid first floor flooding, it would reduce total damages to $27,029 when indexed to 1995 dollars. Average annual damage would be only $1,730.

It is extremely important to note that, at properties where the worst recorded damage was from hurricane 'Bob,' one property reported over 90 percent of the dollar damage. It was the only property reporting either first floor damage or flooding from overland flow. The other 22 damaged buildings reported only basement damage from some water source other than overland flow or out-of-bank flow.

TABLE 3 -- MONETARY DAMAGES BY DAMAGE LOCATION AND WATER SOURCE SAWYER BROOK WATERSHED, SACO, MAINE

CATEGORIES	$	#	#	#	#	#	#
Total Responses Within W/S							159
Never Flooded						78	
Some Damage						81	
To Buildings					64		
To Basements				60			
Sewer Backup			12				
Known $ Damage	14,100	9					
Unknown $ Damage	Est. 4,700	3					
Overland Flow			2				
Known $ Damage	3,500	1					
Unknown $ Damage	Est. 3,500	1					
Out-of-bank Flow			1				
Unknown $ Damage	No Est.	1					
Ground Water			22				
Known $ Damage	12,910	14					
Unknown $ Damage	Est. 7,376	8					
Water Source Not Known			23				
Known $ Damage	20,695	19					
Unknown $ Damage	Est. 4,356	4					
To First Floor				4			
Sewer Backup			1				
Known $ Damage (+ basement)	50,000	1					
Overland Flow			1				
Known $ Damage	250,000	1					
Out-of-bank Flow			1				
Unknown $ Damage	No Est.	1					
Ground Water			1				
Unknown $ Damage	No Est.	1					
To Yards	0				12		
To Roads	0				1		
Location Not Reported	0				4		
TOTALS	**$371,407**	**64**	**64**	**64**	**81**	**159**	**159**
TOTALS (1995 DOLLARS)	**$388,126**						

ENGINEERING METHODS

NRCS uses standard hydrologic and hydraulic study methods to determine the elevation and areal extent of floods arising from many different-sized storms. It analyzes flood events of a magnitude expected to be equaled or exceeded an average of once during any 2-, 5-, 10-, 25-, 50-, 100-, and 500-year period. The common terms for these floods are the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency floods. Although this frequency designation does represent the long term average time between floods of a specific magnitude, floods do not occur at regular, predictable intervals. The more correct terms for these floods are the 50-, 20-, 10-, 4-, 2-, 1-, and 0.2-percent chance flood events, but this report generally will use the long-established and widely recognized 'frequency' designation.

Rare floods could occur at short intervals or even within the same year. When one considers periods greater than 1 year, the risk or probability of experiencing a rare flood increases. For example, the probability of having a flood that equals or exceeds the 1-percent chance (100-year) in any 50-year period is approximately 40 percent (4 in 10), and for any 90-year period, the risk increases to approximately 60 percent (6 in 10.) The analyses reported herein reflect flooding potentials existing at the completion of field surveys for the study.

Hydrologic Analyses

NRCS conducted detailed hydrologic analyses for Sawyer Brook. The POW established the downstream limit for the NRCS flood plain analysis as the inlet to the Sawyer Brook conduit system at Sawyer Street. There are no stream gaging stations within the watershed, and no meaningful surface water flow records exist.

Routine manual or computer-aided computations for subwatershed times of concentration and flood routing reach lengths were made with the aid of large scale topographic maps. NRCS developed composite runoff curve numbers based on existing land use and on future development projections provided by the City.

Technical Release No. 20 (TR-20) is the designation for a watershed computer model entitled Computer Program for Project Formulation - Hydrology **(USDA, SCS, 1983.)** The program is a physically based event model that computes direct runoff resulting from any synthetic or natural rainstorm. It takes into account conditions having a bearing on runoff, develops a hydrograph, and routes the flow through stream channels, reservoirs, and natural storage areas. It combines routed hydrographs with those from other tributaries. The program includes provisions for hydrograph separation by branching or diversion of flow and the addition of baseflow. There is no provision for recovery of initial abstraction or infiltration during periods of no rainfall during an event. TR20 does not have a groundwater component.

The program can compute peak discharges, their times of occurrence, volumes of runoff, water surface elevations, and duration of flows at any desired cross section or structure. It conducts detailed hydrologic analyses to establish the peak discharge-frequency relationships for each flooding source studied.

The TR20 model used historical rainfall data for all evaluated frequencies. Modeled storms had a 24-hour duration and a Type III rainfall distribution. To ensure consistency, NRCS provided all data used in its hydrologic and hydraulic models to DHAI for their use with SWMM or other computer models required by EPA in CSO abatement analyses.

The hydrologic evaluation model established peak discharge-frequency relationships at several key locations along the brook. **Table 4, Peak Discharges (CFS) -- Present Conditions**, summarizes the findings.

TABLE 4 -- PEAK DISCHARGES (CFS) -- PRESENT CONDITIONS SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. 1/ ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	75	140	190	255	305	355	460
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

1/ **Drainage area.**

Initially the City indicated that it was not necessary to change parameters in the hydrologic model to reflect future land use changes, as the watershed already was developed fully. Later in the study the City requested that NRCS evaluate the effects of developing an area in the upper watershed into an industrial park oriented to offices and light industry. NRCS analyzed the effect that this potential land use intensification in three subwatersheds (G, H, and X) would have on surface water discharges on Sawyer Brook. NRCS also analyzed the effect of somehow diverting runoff from those subwatersheds into a watershed next to Sawyer Brook. **Tables 5 and 6** summarize the resulting changes in discharge.

TABLE 5 -- PEAK DISCHARGES (CFS) -- G, H, X INDUSTRIALIZED SAWYER BROOK WATERSHED, SACO, MAINE								
DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	120	190	240	310	365	415	525
Spring Street	162	120	190	240	310	365	415	525
Nye Street	159	120	190	240	310	365	415	525
Park Street	86	80	120	145	180	215	240	295
B&M Railroad	85	80	120	145	180	215	240	295
Roebuck Avenue	82	80	120	145	180	210	240	295
Therrien Avenue	57	70	100	115	140	165	185	220

TABLE 6 -- PEAK DISCHARGES (CFS) -- G, H, X DIVERTED SAWYER BROOK WATERSHED, SACO, MAINE								
DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	108	55	95	130	170	205	235	305
Spring Street	105	55	95	130	170	205	235	305
Nye Street	102	50	90	125	165	195	230	295
Park Street	29	15	25	30	45	50	60	80
B&M Railroad	28	15	25	30	45	50	60	80
Roebuck Avenue	25	10	20	30	40	45	55	70

There is no discharge through the Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

Hydraulic Analyses and Flood Plain Delineation

Detailed hydraulic studies were conducted to provide estimates of the elevations of floods of the selected recurrence intervals. NRCS's Water Surface Profile 2 (WSP2) computer program **(USDA, SCS, 1993)** can provide information on elevation, discharge, flow area, and flooded area at specified locations along a stream valley. The program can compute up to 15 water surface profiles in one pass through the watershed. It uses the standard step method, with some modifications, to compute profiles between valley cross-sections. At a road crossing, it calculates head loss through a bridge opening, culverts, or a combination of them. It can compute flow profiles for subcritical and critical flow. The TR20 program uses valley cross-section hydraulic ratings and structure ratings generated by WSP2 to reach-route flood hydrographs through valley reaches and reservoir route through storage areas.

NRCS conducted field surveys, referenced to the National Geodetic Vertical Datum of 1929 (NGVD), to obtain culvert elevation and structural geometry data, road profiles,

and valley cross-section data along the open channel of Sawyer Brook. **Table 7, Elevation Reference Marks** contains reference mark descriptions used in this study. DHAI included elevations of many other components of the storm and sanitary sewer system on maps within their draft CSO Study Report. The **Flood Plain Maps (Appendix A)** and **Flood Profiles (Appendix B)** show the locations of selected cross sections used in the hydraulic analyses.

TABLE 7 -- ELEVATION REFERENCE MARKS (RM)
SAWYER BROOK WATERSHED, SACO, MAINE

RM #	ELEV.	RM DESCRIPTION
RM 1	73.31	Horizontal nail in steel disk, set in the base of NET&T pole # 8/J18 and CMP #2500 L, at the intersection of North Street and Sawyer Street, west of North Street, south of Sawyer Street, in the north face of the pole and approximately 1 foot above ground level.
RM 2	76.06	Horizontal nail in steel disk, set in the base of CMP pole #22, near the Spring Street crossing of Sawyer Brook, the 2nd pole northeast of Sawyer Brook, on the southeast side of Spring Street, in the northwest face of the pole and approximately 1 foot above ground level.
RM 3	82.11	Horizontal nail in steel disk, set in the base of CMP pole #501, at the Nye Street crossing of Sawyer Brook, the 1st pole northeast of Sawyer Brook, on the northwest side of Nye Street, in the southeast face of the pole and approximately 1 foot above ground level.
RM 4	81.55	Horizontal nail in steel disk, set in the base of NET&T pole #J2, at the 1st pole southwest of Sawyer Brook, on the northwest side of Park Street, in the southeast face of the pole and approximately 1 foot above ground level.
RM 5	90.58	Horizontal nail in steel disk, set in the base of CMP pole #J1, at the intersection of North Street and Roebuck Avenue, east of North Street, south of Roebuck Avenue, in the south face of the pole and approximately 1 foot above ground level.
RM 6	97.31	Horizontal nail in steel disk, set in the base of CMP pole #4/1000L, at the Therrien Avenue crossing of Sawyer Brook, the 1st pole east of Sawyer Brook, on the south side of Therrien Avenue, in the north face of the pole and approximately 1 foot above ground level.

Channel and overbank roughness factors (Manning's "n") were assigned on the basis of field inspection. Manning's "n" is the primary variable, along with segmenting of the cross-section, to facilitate describing the section via multiple "n" values. Up to six segments may be defined for each cross-section. These hydraulic characteristics were analyzed to determine the water-surface elevations of selected floods on Sawyer Brook. Brook cross-section ratings, used to reach route the flood hydrographs, were developed using WSP2.

Table 8, Flood Elevations (NGVD) -- Present Conditions, summarizes these findings and other pertinent elevations. Shaded areas indicate road overtopping.

TABLE 8 -- FLOOD ELEVATIONS (NGVD) -- PRESENT CONDITIONS SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.5	62.6	62.7	62.7	62.8	62.8	62.9
Spring Street	62.5	66.5	71.2	66.6	70.6	71.9	72.2	72.4	72.6	72.9
Nye Street	67.2	71.2	75.9	71.7	75.2	76.5	76.7	76.9	77.0	77.2
Park Street	73.9	76.4	82.0	79.7	82.7	82.9	83.1	83.2	83.3	83.5
B&M Railroad	75.8	79.3	90.7	81.1	87.0	87.4	87.6	87.8	87.9	88.1
Roebuck Avenue	84.1	87.1	90.9	86.2	88.3	89.7	91.3	91.5	91.7	91.9
Therrien Avenue	92.1	94.1	96.1	95.7	96.4	96.5	96.6	96.7	96.7	96.9

Tables 9 and 10 show flood elevations if subwatersheds G, H, and X are industrialized or diverted.

TABLE 9 -- FLOOD ELEVATIONS (NGVD) -- G, H, X INDUSTRIALIZED SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.6	62.7	62.7	62.8	62.9	62.9	63.0
Spring Street	62.5	66.5	71.2	69.3	71.9	72.2	72.4	72.6	72.8	73.0
Nye Street	67.2	71.2	75.9	73.9	76.5	76.7	76.9	77.0	77.2	77.4
Park Street	73.9	76.4	82.0	82.7	83.0	83.1	83.3	83.4	83.5	83.7
B&M Railroad	75.8	79.3	90.7	86.9	87.5	87.7	87.9	88.0	88.1	88.3
Roebuck Avenue	84.1	87.1	90.9	88.2	90.7	91.4	91.7	91.9	92.0	92.2
Therrien Avenue	92.1	94.1	96.1	96.5	96.6	96.7	96.8	96.8	96.9	97.0

TABLE 10 -- FLOOD ELEVATIONS (NGVD) -- G, H, X DIVERTED SAWYER BROOK WATERSHED, SACO, MAINE										
HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.4	62.5	62.6	62.6	62.7	62.7	62.8
Spring Street	62.5	66.5	71.2	65.7	67.7	69.7	71.7	72.0	72.2	72.4
Nye Street	67.2	71.2	75.9	70.8	72.4	74.1	76.3	76.5	76.7	76.9
Park Street	73.9	76.4	82.0	75.7	76.5	79.2	82.4	82.5	82.6	82.8
B&M Railroad	75.8	79.3	90.7	77.8	78.8	80.2	84.1	84.9	85.8	87.1
Roebuck Avenue	84.1	87.1	90.9	85.0	85.5	85.9	86.2	86.4	86.6	88.4

There is no discharge through the Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

NRCS used detailed methods to delineate the 100-year flood plain in areas that reported flooding problems from the Sawyer Brook channel. Nineteen buildings were field surveyed to determine the ground elevation at the foundation, start of damage (low opening) elevation, and first floor elevation. NRCS delineated the 100-year flood plain boundaries shown on the Flood Plain Maps from elevations determined at each surveyed cross section. Between cross sections the boundaries were interpolated using topographic maps at a scale of 1" = 100' and a contour interval of 2 feet. Approximate methods were used where no flood damage was reported from the open channel system.

The hydraulic analyses for this study assumed that flow was unobstructed. The analyses did not consider the effect of ice jams or debris buildup. Thus the flood elevations shown in the tables and on the profiles are valid only if hydraulic structures remain unobstructed, and do not fail. The culverts at both Sawyer Street and Roebuck Avenue have bar racks (trash racks) at their inlets, and the culvert at North Street also has a trash rack on its outlet. Other culverts are small enough in diameter to be susceptible to plugging by debris. During field work, NRCS employees observed residents disposing of significant quantities of brush in the channel. They also saw evidence of the dumping of grass clippings and leaves, roadside sand and gravel, and other debris and trash in the channel.

NRCS evaluated five alternatives for reducing flood stages and damages along Sawyer Brook. They directly relate to measures proposed in the ongoing CSO abatement study being conducted by DHAI. At the request of the City, NRCS added eight alternatives (3, 4, and 8 - 13) later in the study to evaluate the effects of industrializing or diverting subwatersheds G, H, and X.

Alternatives considered the following components:

- Replacing culverts to pass the 100-year flood, the accepted standard for evaluations of flood-prone property and the base flood for the National Flood Insurance Program
- Replacing culverts to pass the 25-year flood, the City standard for design of hydraulic structures
- Industrializing subwatersheds G, H, and X
- Diverting subwatersheds G, H, and X out of the watershed
- Constructing a new Sawyer Brook outlet under Spring Street to pass the 100-year flood to the river
- Diverting subwatershed Y into the watershed

Appendix C, Hydrologic and Hydraulic Alternatives, describes culvert sizes, flood discharges, and flood elevations at each road crossing for the following alternatives. **Appendix E** summarizes cross-section, discharge-frequency, and stage-frequency data at each road crossing.

'Original' Conditions

- Summer 1993
- Present Conditions

Alternatives Without New Spring Street Outlet

1. Present Conditions -- Pass 25-Year Flood
2. Present Conditions -- Pass 100-Year Flood
3. Industrialize Subwatersheds G, H, and X
4. Divert Subwatersheds G, H, and X

Alternatives With New Spring Street Outlet; Subwatershed Y Added

5. Present Conditions
6. Present Conditions -- Pass 25-Year Flood
7. Present Conditions -- Pass 100-Year Flood
8. Industrialize Subwatersheds G, H, and X
9. Industrialize Subwatersheds G, H, and X; Pass 25-Year Flood
10. Industrialize Subwatersheds G, H, and X; Pass 100-Year Flood
11. Divert Subwatersheds G, H, and X
12. Divert Subwatersheds G, H, and X; Pass 25-Year Flood
13. Divert Subwatersheds G, H, and X; Pass 100-Year Flood

Tables 11 and 12 indicate the effects that proposed culvert replacements would have on the 100-year and 25-year flood elevations at road crossings, relative to present conditions. Shaded areas of the tables indicate a change in conditions.

TABLE 11 -- EFFECTS OF ALTERNATIVES ON 100-YEAR (1-PERCENT CHANCE) FLOOD ELEVATIONS AT ROAD CROSSINGS 1/ SAWYER BROOK WATERSHED, SACO, MAINE

CROSSING LOCATION	ORIGINAL CONDITION		WITHOUT NEW 100-YEAR SPRING STREET CONDUIT				WITH NEW 100-YEAR SPRING STREET CONDUIT								
	1993	1995	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12	ALT 13
Sawyer St.	0.0	0.0	0.0	0.0	+0.1	-0.1	--	--	--	--	--	--	--	--	--
Spring St.	0.0	0.0	-0.5	-2.0	+0.2	-0.4	-3.5	-3.5	-3.5	-1.5	-1.4	-1.5	-2.4	-2.4	-2.4
Nye St.	0.0	0.0	-0.4	-1.7	+0.2	-0.3	0.0	-0.4	-1.7	+0.2	-0.5	-1.3	-0.4	-0.6	-2.2
Park St.	0.0	0.0	-0.6	-2.3	+0.2	-0.7	0.0	-0.6	-2.3	+0.2	-0.5	-1.4	-0.7	-1.0	-2.3
B&M RR	0.0	0.0	-0.6	-3.4	+0.2	-2.1	0.0	-0.6	-3.3	+0.2	-0.4	-2.1	-2.1	-2.5	-3.6
Roebuck Av.	+0.4	0.0	0.0	-1.9	+0.3	-5.1	0.0	0.0	-1.9	+0.3	0.0	-0.9	-5.1	-5.1	-5.1
Therrien Av.	+0.1	0.0	-0.1	-0.9	+0.2	2/	+0.1	-0.2	-0.9	+0.2	-0.2	-0.6	2/	2/	2/

TABLE 12 -- EFFECTS OF ALTERNATIVES ON 25-YEAR (4-PERCENT CHANCE) FLOOD ELEVATIONS AT ROAD CROSSINGS 1/ SAWYER BROOK WATERSHED, SACO, MAINE

CROSSING LOCATION	ORIGINAL CONDITION		WITHOUT NEW 100-YEAR SPRING STREET CONDUIT				WITH NEW 100-YEAR SPRING STREET CONDUIT								
	1993	1995	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12	ALT 13
Sawyer St.	0.0	0.0	0.0	0.0	+0.1	-0.1	--	--	--	--	--	--	--	--	--
Spring St.	0.0	0.0	-1.3	-3.5	+0.2	-0.5	-5.7	-5.7	-5.7	-5.4	-5.4	-5.4	-6.2	-6.2	-6.2
Nye St.	0.0	0.0	-1.2	-3.3	+0.2	-0.4	0.0	-1.2	-3.3	+0.2	-1.2	-2.7	-0.5	-2.1	-3.8
Park St.	0.0	0.0	-3.2	-4.1	+0.2	-0.7	0.0	-3.2	-4.1	+0.2	-2.2	-3.2	-0.7	-5.0	-5.1
B&M RR	0.0	0.0	-4.5	-6.0	+0.3	-3.5	0.0	-4.6	-6.0	+0.3	-3.1	-5.2	-3.5	-7.5	-7.4
Roebuck Av.	+0.7	0.0	-2.9	-3.2	+0.4	-5.1	0.0	-2.9	-3.2	+0.4	-2.6	-2.8	-5.1	-5.1	-5.1
Therrien Av.	0.0	0.0	-0.7	-1.9	+0.2	2/	0.0	-0.7	-1.9	+0.2	-0.9	-1.7	2/	2/	2/

1/ Reference condition August 1995. Negative numbers represent a decrease in flood elevations; positive numbers represent an increase in flood elevations.

2/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

The 100-year flood plain delineated on the maps covers an area of about 8 acres. The maps indicate that the 100-year flood may affect about five buildings along the open channel of Sawyer Brook. Owners of two of the five did not respond to the damage survey, and two reported minor basement flooding. The other reported that their property had never been flooded.

Table 13, Effects of Alternatives on Estimated Numbers of Buildings in 100-Year Flood Plain, indicates where proposed culvert replacements and subwatershed diversion could provide limited flood protection benefits.

TABLE 13 -- EFFECTS OF ALTERNATIVES ON ESTIMATED NUMBERS OF BUILDINGS IN 100-YEAR FLOOD PLAIN 1/ SAWYER BROOK WATERSHED, SACO, MAINE

CROSSING LOCATION	ORIGINAL CONDITIONS		WITHOUT NEW 100-YEAR SPRING STREET CONDUIT				WITH NEW 100-YEAR SPRING STREET CONDUIT								
	1993	1995	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12	ALT 13
Sawyer St. to Spring St. 2/	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0
Spring St. to Nye St.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nye St. to Park St. 3/	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Park St. to B&M RR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B&M RR to Roebuck Av.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Roebuck Av. to Therrien Av. 4/	1	1	1	0	1	0	1	1	0	1	1	1	0	0	0
TOTALS	5	5	5	4	5	4	2	2	1	2	2	2	1	1	1

1/ These alternatives will have little effect, if any, on basement flooding caused by a high ground water table.
2/ One of three property owners responded to survey; reported basement flooding.
3/ Property owner responded to survey; claimed no flooding in 15 years of ownership.
4/ Property owner responded to survey; reported basement flooding.

Table 14 summarizes the size and type of culverts analyzed for each alternative evaluated.

The appropriate **Flood Plain Management Options** section contains additional discussion of the effects of these different alternatives.

Field survey information, engineering computations, and other data pertinent to the NRCS component of this study are on file and available for review at the following location:

USDA -- Natural Resources Conservation Service
5 Godfrey Drive
Orono, Maine 04473
Telephone (207) 866-7241

Design Storms - NRCS models evaluated the watershed's flood hazards using 24-hour duration, Type III rainfall distribution for seven different events, the 2-,5-, 10-, 25-, 50-, 100-, and 500-year frequency storms. Data is available for all the above storms.

TABLE 14 -- MINIMUM CULVERT SIZES AND TYPES BY ALTERNATIVE SAWYER BROOK WATERSHED, SACO, MAINE

CROSSING LOCATION	ORIGINAL CONDITIONS		WITHOUT NEW 100-YEAR SPRING STREET CONDUIT				WITH NEW 100-YEAR SPRING STREET CONDUIT								
	1993	1995	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12	ALT 13
Sawyer Street (Inlet)	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP	36" CMP
Spring Street	48" CMP	48" CMP	66" CMP	78" RCP	48" CMP	48" CMP	78" TO 90" RCP	78" TO 90" RCP	78" TO 90" RCP	84" TO 90" RCP	84" TO 90" RCP	84" TO 90" RCP	72" TO 78" RCP	72" TO 78" RCP	72" TO 78" RCP
Nye Street	48" CMP	48" CMP	66" CMP	78" RCP	48" CMP	48" CMP	48" CMP	66" CMP	78" RCP	48" CMP	78" RCP	84" RCP	48" CMP	54" CMP	60" RCP
Park Street	30" CMP	30" CMP	54" CMP	54" RCP	30" CMP	30" CMP	30" CMP	54" CMP	54" RCP	30" CMP	60" CMP	60" RCP	30" CMP	36" CMP	30" RCP
B&M Railroad	3.5'H X 2.0'W CSB	3.5'H X 2.0'W CSB	3.5'H X 3.5'W RCB	4.0'H X 4.0'W RCB	3.5'H X 2.0'W CSB	3.5'H X 2.0'W CSB	3.5'H X 2.0'W CSB	3.5'H X 3.5'W RCB	4.0'H X 4.0'W RCB	3.5'H X 2.0'W CSB	4.0'H X 4.0'W RCB	4.5'H X 4.5'W RCB	3.5'H X 2.0'W CSB	3.5'H X 2.0'W CSB	3.5'H X 2.0'W CSB
Roebuck Avenue	24" CMP	2-36" RCP	2-36" RCP	3.0'H X 6.0'W RCB	2-36" RCP	2-36" RCP	2-36" RCP	2-36" RCP	3.0'H x 6.0'W RCB	2-36" RCP	3-36" RCP	3.0'H x 7.5'W RCB	2-36" RCP	2-36" RCP	2-36" RCP
Therrien Avenue	24" RCP	24" RCP	24" RCP; 2-30" CMP	2.0'H X 8.0'W RCB	24" RCP	2/	24" RCP	24" RCP; 2-30" RCP	2.0'H X 8.0'W RCB	24" RCP	24" RCP; 3-30" CMP	2.0'H X 11.0' W RCB	2/	2/	2/

1/ CMP -- Corrugated Metal Pipe; RCP -- Reinforced Concrete Pipe; CSB -- Cut Stone Box; RCB -- Reinforced Concrete Box.
2/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

Different agencies at different levels of government may choose any storm event as a 'design storm', the selection of which depends upon agency policy and the purpose of the evaluation. NRCS policy is to use the 100-year storm event as the design storm for flood plain management and other flood prevention studies. Use of this storm is consistent with Federal flood damage reduction policy, and with FEMA's National Flood Insurance Program (NFIP). The NFIP uses the 100-year flood elevation as the 'base flood elevation' on the Nation's and City's regulatory Flood Insurance Rate Maps.

EPA uses the 25-year storm for projects funded under the Brownfield Amendment and for Superfund sites. The Maine Department of Environmental Protection's Land and Water Bureau also uses the 25-year storm as a design storm. The City of Saco now uses the 25-year storm in the design of its sanitary and storm sewers and other hydraulic structures including bridges and culverts.

CIVIL RIGHTS IMPACT ANALYSIS

The Secretary of Agriculture has determined that in order to carry out Federal civil rights laws and policies there is a need for USDA agencies to identify and address the civil rights implications of proposed agency actions in their management and decision-making procedures. The Secretary has directed that USDA agencies identify and address the civil rights implications of proposed policy actions before those actions are approved and implemented.

USDA policy is that no person or group shall be discriminated against on the basis of race, color, sex, national origin, religion, age, disability, or marital or familial status in any employment practice or in any program conducted or assisted by the Department of Agriculture.

Civil rights impacts are those consequences of proposed policy actions which, if implemented, will negatively and disproportionately affect the socially and economically disadvantaged, minorities, women, or persons with disabilities who are employees, program beneficiaries, or applicants for employment or program benefits in USDA-conducted or assisted programs by virtue of their race, color, sex, national origin, religion, age, disability, or marital or familial status.

This FPMS delineated the 100-year floodplain, determined flood profiles and discharge capacities of culverts for storm events, and provided general recommendations for the consideration of the Saco City Council, the decision-making body of the study sponsors. All recommendations herein are made for the benefit of all watershed residents regardless of their status and any implementation of those recommendations by the City would not involve USDA policy or programs.

NRCS gathered 1990 Census demographic data pertaining to the above protected groups and reviewed that data with the City of Saco, the study sponsor. The sponsor concurs with NRCS's findings that the demographics of the watershed are not significantly different from that of the City of Saco as a whole, and that no protected groups will be negatively or disproportionately impacted as a result of this FPMS.

FLOOD PLAIN MANAGEMENT OPTIONS

This section provides a technical basis for arriving at solutions to minimize both present and projected damages within the 100-year flood plain and other areas of the watershed. The management options presented provide information on various means of **flood control**, **flood protection**, or **floodproofing** to alleviate monetary loss caused by flooding. Flood control and flood protection often involve costly and complex structural, or 'engineered,' measures. They generally include such items as the following:

- **Removal of channel restrictions**
- **Channel work**
- **Detention and retention storage**
- **Dikes (levees, berms, or floodwalls)**
- **Watershed diversion**

Besides the above, there are five other approaches to dealing with flooding (and water problems):

- **Avoid it** by building in areas suitable for development. This is the general Federal policy of discouraging development and construction in flood plains, pursuant to Executive Order 11988
- If within an unsuitable area, build **above** anticipated water levels
- If within an unsuitable area, erect a **barrier** to water entry -- try to keep dry
- If within an unsuitable area, **plan to get wet but protect damageable property and valuables**
- Buy **insurance**

The design of new structures should incorporate these approaches. If an existing structure is flood-prone, retrofitting may provide protection or reduce damages. The first four of the above approaches are known as:

- **Relocation**
- **Elevation**
- **Floodwalls and dikes**, and **dry floodproofing**
- **Wet floodproofing**

The following discussion considers each approach as it applies to the Sawyer Brook watershed. Nonstructural measures can not prevent the flooding event but they can help alleviate future problems and monetary loss. Any measure would require detailed engineering, environmental, and economic studies to determine its overall feasibility before implementation.

Removal of Channel Restrictions - Undersized or inefficient culverts are the primary restrictions on Sawyer Brook and its tributaries. **Flood Profiles** and **Flood Plain Maps** provide a graphical representation of the effects of these existing restrictions on flood elevations. Discharge and elevation data indicate that improvements are possible, if not always necessary, at all locations.

Midway in the study, participants agreed that the most practicable location for a new outlet for Sawyer Brook would be directly to the Saco River under Spring Street. This outlet also is an integral and necessary part of the City's CSO abatement plan and is designed by DHAI to pass the 25-year flood. NRCS evaluated a similar outlet as a component of nine study alternatives, but designed the outlet to pass the 100-year flood, in accordance with agency policy. Both designs should provide a considerable, but unevaluated, measure of flood protection to the urban area below Sawyer Street.

Alternative 5 would meet NRCS's 100-year and the City's 25-year criteria for areas below Spring Street, including the downtown area. It would provide 100-year flood protection to three of the five properties in the 100-year flood plain between Sawyer Street and Spring Street and lower flood stages between Spring and Nye Streets. It would not provide benefits above Nye Street.

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert

Alternative 6 would exceed the City's 25-year design criteria by incrementally replacing upstream culverts, as below, to allow passage of the 25-year Sawyer Brook flood without overtopping road crossings either at or above Spring Street, as well as providing 100-year capacity at Spring Street. It would not eliminate flood damage to any more properties than would Alternative 5.

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 66" DIAMETER CMP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER CMP CULVERT**
- B&M Railroad -- **ONE NEW 3.5' HIGH BY 3.5' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert plus **TWO NEW 30" DIAMETER CMP CULVERTS**

Alternative 7 would incrementally replace upstream culverts, as below, to allow safe passage of the 100-year flood to the Saco River without overtopping any road crossings along Sawyer Brook. This typically requires somewhat larger culverts made of materials with a longer design life than those in Alternative 6. This alternative would remove one more property, above North Street, from the 100-year flood plain.

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 78" DIAMETER RCP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER RCP CULVERT**
- B&M Railroad -- **ONE NEW 4.0' HIGH BY 4.0' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- **ONE NEW 3.0' HIGH BY 6.0' WIDE RC BOX CULVERT**
- Therrien Avenue -- **NEW 2.0' HIGH BY 8.0' WIDE RC BOX CULVERT**

Replacing culverts will neither reduce damage to nearly 50 properties caused by a high ground water table nor reduce damage to 11 properties caused by overland flow. It would reduce the number of properties in the 100-year flood plain of Sawyer Brook from five to either one or two, depending on the alternative (level of protection) decided upon by the City. None of the 13 alternatives would protect one flood-prone property between Nye and Park Streets. The separation of storm and sanitary sewers as part of the CSO abatement plan should help basement damage caused by sewer backups.

NRCS developed preliminary cost estimates for culvert replacements for most study alternatives, except those involving diversion of subwatersheds G, H, and X (4 and 11 - 13) to Goosefare Brook. Installation of a new Sawyer Brook outlet under Spring Street represents the major part of the overall cost. **Appendix D** includes the individual cost estimate worksheets. The widely-used Means Site Work & Landscape Cost Data was the primary source of unit costs used in developing the cost estimates **(Means, 1993.)** **Table 15** summarizes estimated costs by alternative.

Since 1983 Federal water resource studies have been required to evaluate alternatives from a national perspective **(USWRC, 1983.)** Recommendations should reasonably maximize the net **N**ational **E**conomic **D**evelopment benefits from project implementation. Thus the recommended plan is known as the **NED** Plan. Generally this means that a consumer should get a dollar's worth of benefit for every dollar spent on addressing a problem, in this instance flood damage reduction. In addition, planners must formulate alternatives in consideration of four criteria, known as the 'four tests' -- acceptability, completeness, effectiveness, and efficiency (see **Glossary** for definitions).

TABLE 15 -- SUMMARY OF ESTIMATED COST OF ALTERNATIVES 1/ SAWYER BROOK WATERSHED, SACO, MAINE

CROSSING	ORIGINAL CONDITIONS		WITHOUT NEW 100-YEAR SPRING STREET CONDUIT				WITH NEW 100-YEAR SPRING STREET CONDUIT								
	1993	1995	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12	ALT 13
Sawyer St.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Spring St.	--	--	44.7	56.8	0	--	2406.5	2406.5	2406.5	2447.4	2447.4	2447.4	--	--	--
Nye St.	--	--	38.3	43.9	0	--	0	38.3	43.9	0	43.9	52.6	--	--	--
Park St.	--	--	53.9	61.5	0	--	0	53.9	61.5	0	59.7	68.8	--	--	--
B&M RR	--	--	89.5	95.9	0	--	0	89.5	95.9	0	95.9	101.3	--	--	--
Roebuck Av.	--	159.9	0	159.5	0	--	0	0	159.5	0	84.5	186.1	--	--	--
Therrien Av.	--	--	52.5	92.2	0	--	0	52.5	92.2	0	74.8	134.6	--	--	--
TOTALS	--	159.9	278.9	509.8	0	--	2406.5	2640.7	2859.5	2447.4	2806.2	2990.8	--	--	--

1/ Cost in thousands of dollars ($1,000).

The maximum justifiable expenditure to provide 100-year flood protection and reduce average annual damage to zero dollars, at the present Federal water resource project interest rate of 7 3/4 percent, is calculated by dividing the average annual damage by the amortization rate. **Table 16** summarizes those expenditures, which do not include the cost of operating, maintaining, or replacing the measures.

TABLE 16 -- MAXIMUM JUSTIFIABLE EXPENDITURES TO ELIMINATE REPORTED DAMAGE SAWYER BROOK WATERSHED, SACO, MAINE

MEASURE LIFE (YEARS) 1/	AMORTIZATION RATE	MAXIMUM JUSTIFIABLE EXPENDITURES (1995 DOLLARS)		
		ALL DAMAGE	'BOB' DAMAGE	PRESENT CONDITIONS
10	.14735	168,578	125,212	11,741
25	.09169	270,913	201,222	18,868
50	.07940	312,846	232,368	21,788
100	.07754	320,351	237,942	22,311

1/ **Measure life means that the flood damage reduction measures used would provide protection from the 100-year flood for the specified number of years, then would have to be rebuilt or another measure taken.**

In the Sawyer Brook watershed, none of the hydraulic alternatives meet the Federal guidelines discussed above. Neither the 25-year nor the 100-year solutions are cost-effective from a flood damage reduction standpoint and all fail one or more of the four 'tests'. However, with further study, the City or individuals may find some alternatives to be implementable in a given area.

Considerations in this local evaluation should include:

- Extent of the overall flood problem
- Economics
- Engineering feasibility
- Whether the property is in a high or low hazard area (see **Glossary** for definition)
- Effect on flooding elsewhere (induced flood damages)
- Public pressure and local politics
- Social acceptability
- Relationship to other local land and water resource plans and projects

The estimated cost of the Spring Street outlet necessary for the CSO abatement project (Alternative 5) is $2.4 million. Replacement of upstream culverts to provide 25-year design capacity (Alternative 6) would cost an estimated additional $234,000 and not protect any additional properties. Providing 100-year design capacity would cost an estimated $219,000 more than the 25-year design and protect only one more property.

Economic justification aside, if the City decides to implement any culvert replacements besides the Spring Street outlet in conjunction with the CSO abatement project, NRCS recommends that serious consideration be given to providing capacity for the 100-year flood discharge. The incremental cost of providing taxpayers with a higher level of protection and meeting Federal flood damage reduction policy is small, particularly when compared to the cost of the Spring Street outlet.

No matter what decisions are made, because all culverts are susceptible to clogging, State and City road maintenance crews should make certain to remove brush, sediment, ice, or other debris from all culverts before the peak spring runoff season. They should pay particular attention to crossings that have a history of overtopping and to reaches that have reported flooding problems.

Channel Work - The usual purpose of channel work is to improve the flood carrying capacity and reduce flood damage along a given stream reach. This work can involve changing the channel alignment and widening, deepening, or lining the channel. Lining a channel with a smooth material, such as concrete, increases channel velocities and reduces flood stages.

Structural channels of this type are very expensive, particularly when implemented as remedial measures, and can have significant environmental impacts. Major channel work would be difficult on Sawyer Brook for two reasons. A closed conduit system that passes under existing buildings, and whose condition is unknown, serves the downstream urban area. Developed areas exist along the open channel in close

proximity to the flood plain. The construction area would be limited and both land rights and construction costs likely would be prohibitive.

Fortunately, if the City implements culvert replacement measures discussed above under 'Removal of Channel Restrictions,' there is no need for channel work. The natural channel has the capacity to carry the 100-year discharge in its current state, once an adequate outlet is provided, either at Sawyer Street or upstream at Spring Street.

Detention and Retention Storage - Storage structures, such as dams and ponds, control flood flows by temporarily storing storm runoff in a reservoir and releasing it slowly after the storm passes.

The City's application to FEMA for a Section 404 Hazard Mitigation Grant, to relieve periodic flooding at Roebuck Avenue and North Street, indicated that construction of upstream detention ponds was not possible, citing the proximity of abutting residences and the potential effects upon wetlands. The Best Management Practice (BMP) analysis conducted by the York County SWCD, under contract to DHAI, did not indicate that either detention or retention was practicable. In addition, the Draft CSO Master Plan **(DHAI, 1994)** indicates that there are no areas for wet detention ponds within the watershed; and that costs for subsurface detention ponds are prohibitive.

Relatively early in the study, participants decided not to recommend upstream detention and retention storage as a means of addressing the problems associated with the existing undersized Sawyer Brook outlet. However, if feasible sites can be found, detention is recommended in any development projects where it avoids accentuating problems in the watershed. Retention is recommended for all new projects and generally is required to meet Federal NPDES permit requirements.

Dikes - Earthen floodwater retaining dikes near Sawyer Brook have no practicable application in the watershed. The **Floodproofing** section discusses the use of floodwalls and berms to floodproof individual buildings.

Diversion of Subwatersheds - At the request of DHAI, NRCS analyzed the effects on Sawyer Brook discharges of diverting subwatersheds G, H, and X easterly into the Goosefare Brook watershed and of diverting an adjacent subwatershed, designated as Y, into Sawyer Brook watershed.

The diversion of G, H, and X is a component of Alternatives 4, 11, 12, and 13. It would have positive effects on the Sawyer Brook watershed, as shown in previous tables and discussion. Since NRCS policy is to provide an adequate outlet for any diverted runoff, it would not recommend the diversion without an evaluation of the effects on Goosefare Brook, which reportedly has flood problems as well. That evaluation is outside the scope of this study.

Diversion of the 35 acre subwatershed Y into the Sawyer Brook watershed, which is a component of Alternatives 5 through 13, appears practicable and has been included in NRCS's preliminary design of the 100-year Spring Street outlet. Its effect is to increase discharge and therefore increase the size of the lower end of the outlet pipe.

The Draft CSO Master Plan indicates that 'flow slipping' (diversion of runoff to a downstream inlet or into a downstream subwatershed) is not practical in the Western Downtown Sewer Service Area (which includes the Sawyer Brook watershed) because of local topography and the previous filling of natural surface drainageways.

Land Use Regulation - The City should acquire and enforce conservation, scenic, or flood control restrictions or easements for floodway or flood hazard areas where little or no development is desirable. It should consider the use of land use restrictions or the purchase of future land rights to prevent development that is incompatible with public objectives, while allowing continued private ownership of the land. Permitted uses could be for wildlife habitat, low intensity recreation, and woodland. Land use restrictions also should result in a lowering of the landowner's tax assessment.

The State's 'Mandatory Zoning and Subdivision Control Law' requires all municipal units of government to adopt zoning and subdivision control ordinances for shoreland areas. Shoreland areas include land within 250 feet of the normal high water mark of any pond, river, or salt water body and include a major portion of the flood plain.

The City could enhance the natural and recreational values of Sawyer Brook by adopting new, and enforcing existing, measures that would regulate development within the 100-year flood plain, and in other areas with known stormwater management and ground water problems. This could be done in conjunction with the preparation of an overall use plan that would set integrated objectives for such items as public access, historic sites, recreational areas, and the preservation of remaining undeveloped wetlands and other suitable wildlife habitat areas.

Preservation and Restoration - Considering the suitability of soils for potential uses, the undeveloped areas of the watershed are best suited for idle land, woodland, wetland plants, shallow water areas, wildlife, and non-intensive recreation. From a flood plain management and natural resources conservation viewpoint, the remaining undeveloped areas now are being used as they should be. NRCS recommends modification of the City's land use plan and zoning ordinances to allow for preservation of these areas while the opportunity to do so still exists. There do not appear to be opportunities for restoration of the natural values already lost in developed areas. **Tables 17 and 18** indicate the suitability of soils for recreational development and wildlife habitat.

TABLE 17 -- SOIL LIMITATIONS TO RECREATIONAL DEVELOPMENT SAWYER BROOK WATERSHED, SACO, MAINE

Soil Name & Map Symbol	Camping Areas	Picnic Areas	Playgrounds	Paths & Trails	Golf Fairways
CrB, CuB – Croghan	MODERATE Too Sandy	MODERATE Too Sandy	MODERATE Slope; Too Sandy; Wetness	MODERATE Too Sandy	SEVERE Too Sandy
LnB – Lyman	SLIGHT	SLIGHT	SEVERE Depth to Rock	SLIGHT	SEVERE Depth to Rock
Na – Naumburg	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness
Sa – Saco	SEVERE Floods; Wetness	SEVERE Wetness	SEVERE Floods; Wetness	SEVERE Wetness	SEVERE Floods; Wetness
Sc – Scantic	SEVERE Wetness; Percs Slowly	SEVERE Wetness	SEVERE Wetness; Percs Slowly	SEVERE Wetness	SEVERE Wetness
Ur, UsA	Not specifically rated, but originally composed of above soils.				

TABLE 18 -- WILDLIFE HABITAT POTENTIAL OF SOILS SAWYER BROOK WATERSHED, SACO, MAINE

Soil Name & Map Symbol	Wildlife Habitat Elements							Potential Habitat for:		
	Grain & Seed Crops	Grasses& Legumes	Wild Herbaceous Plants	Hardwood Trees	Coniferous Plants	Wetland Plants	Shallow Water Areas	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
CrB, CuB – Croghan	POOR	FAIR	FAIR	FAIR	FAIR	POOR	VERY POOR	FAIR	FAIR	VERY POOR
LnB – Lyman	POOR	POOR	FAIR	POOR	POOR	VERY POOR	VERY POOR	POOR	POOR	VERY POOR
Na – Naumburg	POOR	FAIR	FAIR	FAIR	FAIR	GOOD	GOOD	FAIR	FAIR	GOOD
Sa – Saco	VERY POOR	POOR	POOR	POOR	POOR	GOOD	GOOD	POOR	POOR	GOOD
Sc – Scantic	POOR	FAIR	FAIR	FAIR	FAIR	POOR	VERY POOR	FAIR	FAIR	VERY POOR
Ur, UsA	Not specifically rated, but originally composed of above soils.									

Best Management Practices - Under contract to DHAI, the York County SWCD determined appropriate Best Management Practices (BMP) for water quality and quantity in the watershed **(YCSWCD, 1995.)** The water quality analysis evaluated loadings of chemical oxygen demand (COD), biological oxygen demand (BOD), total suspended solids (TSS), heavy metals (lead, zinc, and copper), nitrogen as total Kjeldahl nitrogen (TKN), and phosphorus. The analysis first compared existing condition pollutant loads to those with the proposed CSO improvements in place, and then evaluated the effects of BMP's. **Table 19** summarizes the results of the analysis, which appears in **Appendix F**.

TABLE 19 -- CSO/BMP WATER QUALITY ANALYSIS SUMMARY SAWYER BROOK WATERSHED, SACO, MAINE

POLLUTANT	POUNDS DELIVERED TO RECEIVING WATERS			
	WITHOUT BMP'S		WITH BMP'S	
	EXISTING CONDITION	AFTER CSO ABATEMENT	EXISTING CONDITION	AFTER CSO ABATEMENT
COD	1827	2843	1095	1705
BOD	268	373	161	224
TSS	1810	2818	724	1690
Lead	3.80	5.62	2.3	3.4
Zinc	2.49	5.1	1.5	3.1
Copper	.96	1.36	0.6	0.8
TKN	66.55	103.51	40	62
Phosphorus	9.25	14.41	6	9

The CSO abatement project would increase loading rates for each of the above pollutants by about 39 percent (BOD) to as much as 105 percent (zinc). If BMP's (modeled as a filter strip above, and in series with, a grassed swale) were utilized in each subwatershed after CSO abatement, pollutant loadings would decrease from existing condition levels by about 3 percent (phosphorus) to about 17 percent (copper), except for zinc which would increase about 25 percent **(YCSWCD, 1995.)** The establishment and maintenance of the above BMP's as an integral part of the CSO abatement plan appears necessary to maintain the quality of receiving waters.

Other general recommendations include:

- Maintain wetland and flood plain vegetation buffers to reduce sedimentation and delivery of chemicals
- Support BMPs that minimize nutrient flows directly into water bodies
- Support proper use of pesticides and fertilizer on lands within the watershed

Additional technical information on BMPs and other natural resource protection measures is available from the local YCSWCD office.

Flood Insurance - Saco is a participant in the 'regular' phase of the National Flood Insurance Program (NFIP.) This program enables existing dwellers within the 100-year flood plain to buy up to $245,000 worth of flood insurance on their home and contents at subsidized rates ($550,000 for multifamily homes and small businesses.) Before this study only areas affected by Saco River floods had 100-year flood plains delineated. When the flood plains delineated along parts of Sawyer Brook through this study are incorporated into regulatory Flood Insurance Rate Maps, new owners of financed properties will be required by lending institutions to carry flood insurance as a condition of loan approval.

The community should require building permits for all proposed construction in areas that may be flood-prone and review the permit to ensure the sites are reasonably free from flooding. It also should require that structures in flood-prone areas be properly anchored and that construction materials and methods be used that will minimize flood damage **(COE, 1992.)**

The City should ensure that owners of structures along or near the Sawyer Brook and Saco River flood plains are aware of the availability of Federally subsidized flood insurance under the NFIP. Policies and information on coverage and rates are available from most insurance agents. Agents unfamiliar with the program may call the Federal Insurance Administration at 1-800-638-6620 or (617) 848-1908 for assistance.

Floodways - One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting flood hazard increase. Under this concept, the 100-year flood plain is divided into a floodway and a floodway fringe.

The floodway is the main channel of the watercourse plus any adjacent flood plain areas that must be kept clear so that the 100-year flood can be conveyed without substantial increase in flood heights. FEMA minimum standards limit such increases in flood heights to 1.0 foot, provided that hazardous velocities do not result. The floodway fringe includes that part of the flood plain that can be completely obstructed without increasing the 100-year flood elevation by more than 1.0 foot at any point.

Any encroachment in the flood plain that increases the elevation of the land or obstructs flood flows will reduce the flood carrying capacity, resulting in increased flood heights and flow velocities. Flood hazards, both upstream and downstream of the encroachment, generally will increase in these situations. A good example on Sawyer Brook is the building that suffered hundreds of thousands of dollars of damage from hurricane 'Bob'. The building itself was the encroachment.

In that particular instance the opportunity exists to partially remedy the encroachment by excavating horizontally away from the ends of the building foundation to reduce the

'damming' effect of the building and parking lot fill. The parking lot could be reshaped to provide a total flow area adequate to pass overland flows around the building.

This would avoid impounding water to a depth of 5 or 6 feet behind the building until floodwater enters, causing hundreds of thousands of dollars of damage. In simple terms, make the building an island, not a dam. It would be necessary to evaluate the effects of this action on properties downstream that could suffer induced damages if the owners or the City considers this remedy. Those properties already are within the 500-year floodplain.

NRCS computed theoretical floodways for Sawyer Brook on the basis of equal conveyance reduction from each side of the flood plain. This report does not include floodway data. Interested parties may review that data by visiting the NRCS office at the following address:

USDA -- Natural Resources Conservation Service
5 Godfrey Drive
Orono, Maine 04473
Telephone (207) 866-7241

Warning Signs and Flood Markers - One proven method of discouraging flood plain development is to erect flood warning signs or markers in flood-prone areas or to prominently post previous or predicted flood levels. This is a viable option for some areas of the Sawyer Brook watershed, and the rest of the City. These markers carry no enforcement, but simply serve to inform the public of the extent of the existing flood hazard.

FLOOD HAZARD

Flood Warning and Response Systems - In some communities flood warning and response systems are important in the reduction of flood loss. These systems use rainfall and water level information from upstream areas to predict flood stages downstream and provide warning of likely flooding. This provides time for residents of the flood plain and emergency management agencies to evacuate people and animals, move belongings, and otherwise prepare for the flood. The State employs such a system statewide for major rivers such as the Saco.

There is no need, or economic justification, for a flood warning system in Sawyer Brook. Flood damages are low. Drainage areas are so small that such a system would not provide timely warning of flooding. Many residents with a history of basement flooding already know when the water table will rise and it is time to rent a large sump pump or check the operation of an existing one.

Floodproofing is any measure, or combination of measures such as those introduced at the beginning of this section, that property owners might take to minimize damages to their property. It is a complex subject that is too lengthy to discuss fully here. City officials and property owners are encouraged to order and study the floodproofing publications listed later in the **Information and Education** section of this report. These publications are the source of the following discussions.

Relocation - Moving a structure out of the flood plain so it is no longer affected by flood waters is the single most effective floodproofing measure. It applies when property owners want to eliminate flood risks, when the flood hazard is high, and when communities believe the flood plain should be used more appropriately. In areas where the danger of flooding is so great as to render all other means of flood protection ineffective or impractical, Federal or state funds may be available to buy properties outright or relocate buildings or their occupants. Once the buildings have been razed or relocated the land may be used for any of several more suitable purposes not significantly affected by floodwaters. Costs can be high and the building must be structurally sound to withstand the moving process. Experienced, qualified building movers should be consulted.

Because the flood risk is low, relocation has no widespread application on Sawyer Brook.

Elevation - Raising a structure so the lowest floor is above flood levels is a very effective measure. Depending on the flood situation and the construction and condition of the building, elevation can be on fill, foundation walls, piers, posts, columns, or walls. Costs vary accordingly. Elevating on fill can result in additional floodway encroachment.

Barriers - Small, free-standing earth berms or concrete floodwalls are effective means of preventing shallow flood waters from reaching a building. Berms require a large 'footprint', so the more costly floodwalls are used where space is limited.

Both are susceptible to underseepage, and may not be appropriate for buildings with basements on saturated or permeable soils.

Dry Floodproofing - This barrier technique involves sealing all flood-prone areas of a structure to make it watertight. Property owners can use impermeable film or sheets, or one of a variety of spreadable commercial waterproofing compounds, to waterproof walls. They can permanently close openings or fit them with removable shields, shutoff valves, etc.

This technique is **NOT** appropriate for buildings with basements or crawl spaces since underseepage can not be prevented. It applies where flood waters are less than 3 feet deep outside the building and only when someone always is available to take action when warned of impending flooding.

Wet Floodproofing - This technique allows water to enter the structure because measures have been taken to eliminate water damage. This may involve relocating damageable items such as furnaces, electrical service entrances, and laundry appliances permanently to areas above or outside of anticipated flood levels. Some items such as washers, dryers, and freezers can be wrapped in specially made waterproof bags. Someone needs to be available and trained on what actions are necessary when warned of an impending flood. Building materials that are not susceptible to water damage can be used in flood-prone parts of a building.

Basement Protection - The following are some of the more common basement protection techniques that could prove useful to the many property owners reporting basement water damage in the City's flood damage survey **(COE, 1991.)**

- Install, or increase the number or capacity of, sump pumps in the basement and provide an alternative source of electrical power in the event of a power outage. Conduct routine maintenance.
- Install backflow prevention devices or standpipes in the sanitary sewer system and floor drain outlets.
- Install a subsurface drainage system around the foundation walls and seal the walls with a waterproofing compound.
- Use wet floodproofing techniques by moving basement equipment and contents to a higher elevation. Allow water to enter the basement, as there is nothing to damage.
- As a last resort, abandon and fill basements that extend below normal high water tables with sand or gravel and pour a slab.

Several structures in the Sawyer Brook watershed could derive benefit from floodproofing. Property owners should consult a qualified professional with floodproofing experience and consider the following when selecting the most appropriate measure or combination of measures:

- Depth, velocity, and duration of flood flows
- Benefit/cost ratio of the measure
- Engineering feasibility
- Soil types
- Local codes and building restrictions

The next section of this report contains many additional sources of information.

" Most flood problems occur because man has chosen poorly in deciding where to build. "

Floodplain Management Handbook, U.S. Water Resources Council, 1981.

INFORMATION AND EDUCATION

Persons interested in building any structure or facility need a great deal of information about the site under consideration, and need to know how to deal with special problems associated with the site. Much information already may be available, while some will need to be gathered. This section will discuss where to obtain available information about soil suitability and flooding.

Soil Suitability for Development - It is essential to thoroughly evaluate and investigate onsite soils as a part of the development planning process **(USDA, SCS & NHDES, 1991.)** The impact of development typically is high for soils that:

- Are fine grained
- Are shallow to bedrock
- Are wet or poorly drained
- Flood
- Have a high water table
- Have steep slopes

Ignoring soil and geologic site conditions or other design considerations usually results in the following:

- Higher initial site preparation and construction costs
- Expensive contract modifications
- Total or partial loss of design function
- Dissatisfied customers
- Excessive operation, maintenance, and replacement costs
- Costly remedial measures or design changes to restore the function
- Degradation of the environment

Although steep slopes are relatively infrequent, all the other conditions and effects apply to the Sawyer Brook watershed.

Before considering any future site development activities, City planners, regulatory, and permitting officials; developers; and other interested individuals should evaluate the available soil resource information by visiting the local SWCD office at:

York County Soil and Water Conservation District
160 Cottage Street
Sanford, Maine 04073
Telephone (207) 324-7015

Tables 20 through 23 indicate the suitability of the watershed's soils for various aspects of development. Note that **all soils within the watershed have moderate to severe limitations for building site development** and for septic tank absorption fields. Five of the six soils are wet and the sixth is erosive, shallow to bedrock, and droughty. Residents responding to the damage survey complained of high ground water tables, surface water ponding, poor and slow drainage, sewer and basement drain backup, and other problems attributable to development on unsuitable soils.

TABLE 20 -- SOIL LIMITATIONS TO BUILDING SITE DEVELOPMENT SAWYER BROOK WATERSHED, SACO, MAINE

Soil Name & Map Symbol	Shallow Excavations	Dwellings Without Basements	Dwellings With Basements	Small Commercial Buildings	Local Roads & Streets	Lawns & Landscaping
CrB, CuB -- Croghan	SEVERE Wetness; Cutbanks Cave	MODERATE Wetness; Frost Action	SEVERE Wetness	MODERATE Slope; Wetness; Frost Action	MODERATE Frost Action	SEVERE Too Sandy
LnB -- Lyman	SEVERE Depth to Rock	SEVERE Depth to Rock	SEVERE Depth to Rock	SEVERE Depth to Rock	SEVERE Depth to Rock	SEVERE Depth to Rock
Na -- Naumburg	SEVERE Wetness; Cutbanks Cave	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness	SEVERE Wetness
Sa -- Saco	SEVERE Floods; Wetness; Cutbanks Cave	SEVERE Floods; Wetness; Frost Action	SEVERE Floods; Wetness	SEVERE Floods; Wetness; Frost Action	SEVERE Floods; Wetness; Frost Action	SEVERE Floods; Wetness
Sc -- Scantic	SEVERE Wetness; Too Clayey	SEVERE Wetness; Frost Action	SEVERE Wetness	SEVERE Wetness; Frost Action	SEVERE Wetness; Low Strength; Frost Action	SEVERE Wetness
Ur, UsA	Not specifically rated, but originally composed of above soils.					

TABLE 21 -- SOIL LIMITATIONS TO SANITARY FACILITY DEVELOPMENT SAWYER BROOK WATERSHED, SACO, MAINE

Soil Name & Map Symbol	Septic Tank Absorption Fields	Sewage Lagoon Areas	Trench Sanitary Landfill	Area Sanitary Landfill	Daily Cover for Landfill
CrB, CuB -- Croghan	SEVERE Wetness	SEVERE Seepage; Wetness	SEVERE Seepage; Wetness; Too Sandy	SEVERE Seepage; Wetness	POOR Too Sandy
LnB -- Lyman	SEVERE Depth to Rock	SEVERE Depth to Rock; Seepage	SEVERE Depth to Rock; Seepage	SEVERE Seepage	POOR Thin Layer; Area Reclaim
Na -- Naumburg	SEVERE Wetness	SEVERE Wetness; Seepage	SEVERE Wetness; Seepage	SEVERE Wetness; Seepage	POOR Wetness; Area Reclaim
Sa -- Saco	SEVERE Floods; Wetness	SEVERE Floods; Wetness; Seepage	SEVERE Floods; Wetness; Seepage	SEVERE Floods; Wetness; Seepage	POOR Wetness
Sc -- Scantic	SEVERE Percs Slowly; Wetness	SLIGHT	SEVERE Wetness; Too Clayey	SEVERE Wetness	POOR Wetness; Thin Layer
Ur, UsA	Not specifically rated, but originally composed of above soils.				

TABLE 22 -- SUITABILITY OF SOIL AS CONSTRUCTION MATERIAL SAWYER BROOK WATERSHED, SACO, MAINE

Soil Name & Map Symbol	Roadfill	Sand	Gravel	Topsoil
CrB, CuB -- Croghan	GOOD	GOOD	UNSUITED Excess Fines	POOR Too Sandy
LnB -- Lyman	POOR Thin Layer; Area Reclaim	UNSUITED Excess Fines; Thin Layer	UNSUITED Excess Fines; Thin Layer	POOR Thin Layer; Area Reclaim
Na -- Naumburg	POOR Wetness; Area Reclaim	FAIR Excess Fines	UNSUITED Excess Fines	POOR Wetness; Too Sandy
Sa -- Saco	POOR Wetness; Frost Action	FAIR Excess Fines	UNSUITED Excess Fines	POOR Wetness
Sc -- Scantic	POOR Frost Action; Wetness; Low Strength	UNSUITED Excess Fines	UNSUITED Excess Fines	POOR Wetness
Ur, UsA	Not specifically rated, but originally composed of above soils.			

TABLE 23 -- SOIL LIMITATIONS FOR WATER MANAGEMENT PRACTICES SAWYER BROOK WATERSHED, SACO, MAINE						
Soil Name & Map Symbol	Embankments, Dikes, & Levees	Aquifer-fed Excavated Ponds	Drainage	Irrigation	Terraces & Diversions	Grassed Waterways
CrB, CuB -- Croghan	Seepage; Unstable Fill; Piping	Deep to Water; Cutbanks Cave	Cutbanks Cave	Seepage; Fast Intake	Too Sandy	Erodes Easily; Droughty
LnB -- Lyman	Thin Layer; Seepage	No Water; Depth to Rock	Not Needed	Depth to Rock; Slope; Rooting Depth	Depth to Rock; Slope	Slope; Depth to Rock; Droughty
Na -- Naumburg	Piping; Seepage	Cutbanks Cave	Cutbanks Cave; Wetness	Fast Intake; Wetness	Not Needed	Not Needed
Sa -- Saco	Piping; Wetness	Favorable	Floods; Frost Action	Wetness; Floods	Not Needed	Not Needed
Sc -- Scantic	Hard to Pack; Wetness	Slow Refill	Percs Slowly; Frost Action; Slope	Wetness; Percs Slowly; Slope	Wetness; Percs Slowly; Erodes Easily	Wetness; Percs Slowly; Erodes Easily
Ur, UsA	Not specifically rated, but originally composed of above soils.					

Flood Reference Library - Every property owner that reported water damage from hurricane 'Bob', lives near Sawyer Brook or the Saco River, lives where water tables are high, or lives where stormwater management measures are inadequate should be advised of the availability of the following publications that deal with flood areas, floodproofing, and cleanup after flooding. Single copies are free of charge.

The following publications are available from:

Federal Emergency Management Agency
Publications
P.O. Box 70274
Washington, DC 20024

- **Coastal Construction Manual (FEMA 55)**

  A 210 page illustrated technical manual for construction and retrofitting of residential and non-residential structures resistant to flood, wind, and erosion damage.

- **Design Manual for Retrofitting Flood-prone Residential Structures (FEMA 114)**

  This 265 page profusely illustrated manual includes techniques and considerations for elevating or relocating structures; wet and dry floodproofing measures; utility protection; and a matrix for choosing the best method for a particular situation. It is a detailed, technical, but readily understood, discourse on floodproofing measures for residences.

- **Elevated Residential Structures (FEMA 54)**

  This 135 page non-technical manual illustrates numerous examples of how buildings may be elevated above flood levels.

- **Floodproofing Non-residential Structures (FEMA 102)**

  A variety of permanent and emergency floodproofing techniques for non-residential structures are described in this 200 page illustrated manual. It includes case studies, assistance programs, and a method selection matrix.

- **Manufactured Home Installation in Flood Hazard Areas (FEMA 85)**

  This 100 page illustrated manual covers the elevation and anchoring of a manufactured (mobile) home to reduce flood and wind damage.

- **Repairing Your Flooded Home (FEMA 234)**

  This 53 page illustrated manual for owners of flood-prone property discusses how floods damage buildings, how to minimize damage through implementation of emergency floodproofing measures, cleanup of common household items after the flood, repair of damages, and planning for the next flood. This manual was prepared in cooperation with the American Red Cross (ARC.) Copies of this publication (as ARC 4477) also are available from your local ARC Chapter.

The following publications are available from:

U.S. Army Corps of Engineers
Attn: CECW-PF
20 Massachusetts Avenue, NW
Washington, DC 20314

- **Flood Proofing Regulations (EP 1165-2-314)**

  This 80 page document provides specifications for the construction of floodproofed buildings and material lists for those areas to be wet floodproofed. It is written to enable the easy adoption of building codes and regulations by municipalities.

- **Flood Proofing Systems & Techniques**

  This 100 page manual is an illustrated guide to examples of floodproofing measures used to protect a variety of structures across the United States.

Additional information on flood plain management issues can be obtained from the following State agencies:

State Flood Plain Management Coordinator
Department of Economic & Community Development
Office of Community Development
State House Station 130
Augusta, ME 04333
(207) 624-6800

and the

Maine Emergency Management Agency
State House Station 72
Augusta, ME 04333
(207) 287-4080 or 1-800-452-8735

and locally from:

York County Emergency Management Agency
County Court House
Court Street
Alfred, ME 04002
(207) 324-1578

Training - The U.S. Army Corps of Engineers, under its Flood Plain Management Services Program, conducts several types of planning studies and training activities that may be of interest to the City of Saco and its citizens. These services are provided free of charge to local governments and include the following:

- Urbanization impact studies
- Stormwater management studies
- Floodproofing studies
- Inventories of flood-prone structures
- Guidance for compliance with the NFIP
- Seminars and workshops on nonstructural flood plain management measures

The following COE water resources planning office serves Saco:

U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149
(617) 647-8255

The State Floodplain Management Coordinator's office provides periodic training to local officials, oriented to code enforcement officers, on the NFIP and flood plain management topics.

CONCLUSIONS AND RECOMMENDATIONS

Conduct of this study has led to the following conclusions and recommendations.

Drainage Problems

Study participants believe the high level of cooperation shown by residents and the nature of their flood damage survey responses attests to a consensus that the drainage problems in the Sawyer Brook watershed are significant. Merchants in the Saco Valley Shopping Center and residents in many other areas of the watershed continue to express concern with deficiencies in the drainage system.

Residents responding to the damage survey indicate that property damage caused by out-of-bank flooding from the open Sawyer Brook channel is not a significant problem, even during hurricane 'Bob.' Over 90 percent of the total dollar damage from 'Bob' occurred to the one and only property reporting either first floor damage or flooding from overland flow. The other 22 damaged buildings reported only basement damage from some water source other than overland flow or out-of-bank flow. Owners of two of the five buildings in the 100-year flood plain did not respond to the damage survey, and two reported minor basement flooding. The other reported that their property had never been flooded.

Wet basements are a widespread problem in the watershed. Residents complained of high ground water tables, surface water ponding, poor and slow drainage, sewer and basement drain backup, and other problems. Over 75 percent of the reported problems, particularly basement flooding and poor drainage, relate directly to development in unsuitable areas.

All soils within the watershed have moderate to severe limitations for building site development and for septic tank absorption fields. Five of the six soils are wet and the sixth is erosive, shallow to bedrock, and droughty. Geologic and soils maps and interpretive data indicate that seasonal high water tables in the entire watershed lie between the surface and a 2-foot depth for over 6 months a year on all but Lyman soils. It is probable that ground water, not sewer backup, overland flow, or out-of-bank flow, damages most buildings (49 of 64).

CSO Abatement

Abatement of CSO's to prevent degradation of water quality in receiving waters and to prevent violations of state and Federal water quality standards will require separation of about 70 acres of the natural Sawyer Brook watershed that now discharge to the combined sewer system. The old Sawyer Brook culvert system that runs under part of downtown, from its inlet at Sawyer Street to the Saco River, is woefully inadequate. Sawyer Street overtops during storms as small and frequent as the 2-year storm.

The long term and full abatement of CSO's can not occur in the City of Saco until the old Sawyer Brook culvert system (trunk drain) is replaced. Otherwise, drainage problems will get worse.

Participants agree that the most practicable location for a new outlet for Sawyer Brook would be directly to the Saco River under Spring Street. Diversion of the 35 acre subwatershed Y into the Sawyer Brook watershed and this outlet appears practicable. Its effect is to increase discharge and therefore increase the size of the lower end of the outlet pipe.

This new outlet is an integral and necessary part of the City's CSO abatement plan. During the CSO abatement study, DHAI developed the initial design for this outlet, the Sawyer Brook storm drain, to pass the 25-year flood. DHAI's opinion of construction cost is about $2.27 million.

NRCS developed a preliminary design for a comparable outlet as a component of nine study alternatives. **Alternative 5** would upgrade the old, inadequate system to meet the 100-year design storm standards of NRCS and the National Flood Insurance Program, and to exceed the City's 25-year criteria. It would provide 100-year flood protection to three of the five properties in the 100-year flood plain between Sawyer Street and Spring Street and lower flood stages as far upstream as Nye Street. The NRCS preliminary design and construction cost estimate for this alternative is about $2.41 million.

Either design would provide a considerable, but unevaluated, measure of flood protection to the urban area below Sawyer Street. The separation of storm and sanitary sewers as part of the CSO abatement plan should reduce basement damage caused by sewer backups.

Other Culvert Replacements

The 100-year flood plain of Sawyer Brook above Sawyer Street is about 8 acres in size. The 100-year flood may affect about five buildings along the open channel of Sawyer Brook.

Sawyer Brook culverts are undersized. A 25-year storm, the City's 'design storm,' now would cause every street that crosses Sawyer Brook to be overtopped by floodwater from the Sawyer Brook channel. Floodwater would not overtop the B&M Railroad fill, even during the 100-year storm.

The new Spring Street outlet would make it practicable to replace and upgrade Sawyer Brook culvert crossings upstream of Spring Street. The natural channel has the capacity to carry the 100-year discharge in its current state, once an adequate outlet exists.

Study **Alternative 6** would replace upstream culverts to pass the 25-year flood without overtopping road crossings. This work would not protect any more upstream properties from the 100-year flood. NRCS estimates the cost at about $234,000.

Study **Alternative 7** would replace upstream culverts to pass the 100-year flood without overtopping road crossings. This typically requires somewhat larger culverts made of materials with a longer design life than those in Alternative 6. This work would protect one more upstream property from the 100-year flood. NRCS estimates the cost at about $453,000 or $219,000 more than Alternative 6.

Culvert replacement above Spring Street to provide flood protection to the two properties within the 100-year flood plain of Sawyer Brook is not justified. Neither the 25-year nor the 100-year solutions are cost-effective from a flood damage reduction standpoint. Costs can not be justified based on the NED plan and its associated tests of acceptability, completeness, effectiveness, and efficiency. In the Sawyer Brook watershed, none of the hydraulic alternatives meet the Federal guidelines discussed above, and all fail one or more of the four 'tests'.

The new Spring Street outlet and any level of culvert replacements upstream would do very little to alleviate several types of problems reported in the damage survey. Replacing culverts would neither reduce damage to nearly 50 properties caused by a high ground water table nor reduce damage to 11 properties caused by overland flow. It would reduce the number of properties in the 100-year flood plain of Sawyer Brook from five to either one or two, depending on the alternative (level of protection) decided upon by the City. None of the 13 alternatives would protect one flood-prone property between Nye and Park Streets.

Culvert replacement should be considered city-wide, however, based on meeting the City's design standards and for public safety reasons. Flooded roads can seriously impact pedestrian and vehicular travel during times of emergency. NRCS recommends use of the 100-year design storm to meet Federal flood damage reduction objectives, particularly if the additional cost is reasonable.

The diversion of subwatersheds G, H, and X to Goosefare Brook is a component of Alternatives 4, 11, 12, and 13. It would have positive effects within the Sawyer Brook watershed. Effects on Goosefare Brook, which reportedly has flood problems as well, were not evaluated.

The industrialization of subwatersheds G, H, and X is a component of Alternatives 3, 8, 9, and 10. It would increase discharges, require replacement of all existing culverts to meet the 25-year design standard, and add from about $41,000 to about $591,000 to the cost of Alternative 5.

To prevent the deterioration of water quality, new development should include the use of all applicable Best Management Practices (BMP's) where feasible. The establishment and maintenance of filter strips and grassed swales to treat and trap pollutants should be an integral and necessary part of the CSO abatement plan.

Relatively early in the study, participants decided not to recommend upstream detention and retention storage as a means of addressing the problems associated with the existing undersized Sawyer Brook outlet. Detention basins are recommended in any development projects where they will avoid accentuating and increasing peak flows in the watershed. Retention is recommended for all new projects and generally is required to meet Federal NPDES permit requirements.

'Flow slipping' (diversion of runoff to a downstream inlet or into a downstream subwatershed) is not practicable because of local topography and the previous filling of natural surface drainageways.

Management Options

City codes and ordinances help minimize loss of life and property damage from future floods, prevent degradation of the watershed's environmental resources, and ensure orderly community growth in areas suitable for development. The City should use the data and recommendations in this report to reduce nuisance flooding problems; as a guide for implementing a flood plain management program for the watershed and the remainder of the City; and to complement the ongoing combined sewer overflow (CSO) abatement effort.

The City should review building permits for all proposed construction to ensure the building will be reasonably free from flooding and groundwater problems and does not encroach into the natural flood plain. It also should require that structures in flood-prone areas use construction materials and methods that will minimize flood damage.

Future development within the watershed should be carefully planned and controlled. Before considering any future site development activities, City planners, regulatory, and permitting officials; developers; and other interested individuals should evaluate available soil resource information by visiting the local SWCD office in Sanford.

The data generated by this study should be made available to local, state, and Federal agencies, planning groups, engineers, consultants, and others involved in community planning and the design of hydraulic structures, conduits, channels, roads, bridges, culverts, and other community facilities.

The City should consider amending its flood plain base maps to reflect the findings of this study. To inform the public of the extent of the existing flood hazard, the City should consider erecting flood warning signs or markers in flood-prone areas or to prominently post previous or predicted flood levels. The City should ensure that

residents in flood-prone areas are aware that Federally subsidized flood insurance under the NFIP is available from most insurance agents.

The City should acquire and enforce conservation, scenic, or flood control restrictions or easements for floodway or flood hazard areas where little or no development is desirable. It should consider the use of land use restrictions or the purchase of future land rights to prevent development that is incompatible with public objectives, while allowing continued private ownership of the land. Permitted uses could be for wildlife habitat, low intensity recreation, and woodland. Land use restrictions also should result in a lowering of the landowner's tax assessment.

The City could enhance the natural and recreational values of Sawyer Brook by adopting new, and enforcing existing, measures that would regulate development within the 100-year flood plain, and in other areas with known stormwater management and ground water problems. This could be done in conjunction with the preparation of an overall use plan that would set integrated objectives for such items as public access, historic sites, recreational areas, and the preservation of remaining undeveloped wetlands and other suitable wildlife habitat areas.

Considering the suitability of soils for potential uses, the undeveloped areas of the watershed are best suited for idle land, woodland, wetland plants, shallow water areas, wildlife, and non-intensive recreation. NRCS recommends that the City consider modification of its land use plan and zoning ordinances to allow for preservation of these areas and the watershed's small NWI wetlands while the opportunity to do so still exists. There do not appear to be opportunities for restoration of the natural values already lost in developed areas.

The City should consider acquisition of easements and enactment of ordinances to protect the natural remnants of Sawyer Brook. The brook is currently adequate for flow conveyance but is being used for deposition of brush, yard clippings, leaves, and other debris which could result in loss of capacity if it continues in the future. This debris also increases the opportunity for blockage of culvert inlets.

Information and Education

Every property owner that reported water damage from hurricane 'Bob,' lives near Sawyer Brook or the Saco River, lives where water tables are high, or lives where stormwater management measures are inadequate should be advised of the availability of publications that deal with flood areas, floodproofing, basement protection techniques, and cleanup after flooding. Single copies are free of charge.

Several structures in the Sawyer Brook watershed could derive benefit from floodproofing. Property owners should consult a qualified professional with floodproofing experience to help with selection of the most appropriate measure or combination of measures:

The City should consider sponsoring and participating in workshops and training on flood plain management topics, the NFIP, and floodproofing measures. Many activities are provided free of charge to local governments by the U.S. Army Corps of Engineers and the State Floodplain Management Coordinator's office.

Civil Rights Impacts

The NRCS official responsible for the civil rights impact analysis for this FPMS has determined that civil rights impacts have been identified and adequately addressed. No protected groups will be negatively or disproportionately impacted as a result of recommendations included in this study.

GLOSSARY

Acceptability - The workability and viability of an alternative plan with respect to acceptance by State and local entities and the public, and compatibility with existing laws, regulations, and public policies.

Aquifer - A body of soil or rock that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells or springs.

CFS or cfs - Cubic feet per second. Used to describe the amount of flow passing a given point in a stream channel. One cubic foot per second is equivalent to approximately 7.5 gallons per second.

Channel - A natural or artificial watercourse with definite bed and banks to conduct and confine flowing water.

Completeness - The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Cross Section - A graph or plot of ground elevation across a stream valley or a portion of it, usually along a line perpendicular to the stream or direction of flow.

Effectiveness - The extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

Efficiency - The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

Erosion - The group of processes whereby soil or rock material becomes loosened or dissolved and removed from any part of the earth's surface.

Flood - An overflow or inundation onto land areas not normally covered by water that are used or usable by people. Floods usually are characterized as temporarily inundating land areas which are adjacent to a body of water such as an ocean, lake, stream, or river.

Flood Crest - The maximum stage or elevation reached by the waters of a flood at any location.

Flood Plain - The relatively flat area of lowlands adjoining the channel of a river, stream, watercourse, ocean, lake, or other body of standing water that has been or may be covered by floodwater.

Flood Plain Management - The operation of a program intended to lessen the damaging effects of floods, maintain and enhance natural values, and make effective use of water and land resources within the flood plain. It is an attempt to balance values obtainable from use of flood plains with potential losses arising from such use. Flood plain management stresses consideration of a full range of the measures potentially useful in achieving its objectives.

Flood Plain Map - A map showing the lateral extent of flooding. Maps in this report show the 100-year flood plain.

Flood Profile - A graph that shows the relationship of water surface elevation to distance along the centerline of the channel. This report uses profiles to show the crest elevations of the 10- and 100-year floods.

Floodproofing - A combination of structural changes or adjustments to new or existing structures and facilities, their contents, or their sites for the purpose of reducing or eliminating flood damages by protecting against structural failure, keeping water out, or reducing the effect of water entry.

Flood Warning - The issuance and dissemination of information about an imminent or current flood.

Floodway - That portion of the main stream channel plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights.

Floodway Fringe - That part of the flood plain that can be completely obstructed without increasing the 100-year flood elevation by more than 1.0 foot at any point.

Frequency - A statistical measure of how often a flood event of a given size or magnitude should, on the average, be equaled or exceeded.

Ground Water - Water that occupies open spaces beneath the ground surface. These spaces may be openings between soil particles such as sand and gravel; fractures in bedrock; and, unfortunately for some property owners, basements.

Head - The height of water above any plane of reference.

Head Loss - The effect of obstructions, such as narrow bridge openings or buildings, that limit the area through which water must flow, raising the surface of the water upstream of the obstruction.

High Hazard Zone - An area, normally nearest the stream, where flooding may pose a significant risk to life and property. Areas having any one of the following conditions generally are considered high hazard:

- Areas where flood velocities exceed 5 feet per second (fps)
- Areas where flood depths are greater than 3 feet
- Areas where the product of the velocity (in fps) and the depth (in feet) of the flood water exceeds seven

Hydric Soil - A soil with characteristics that indicate either slow permeability (less than 6 inches per hour) or has a subsoil that shows the presence of water saturated conditions for a prolonged time (usually 2 weeks or more.)

Low Chord - The elevation at which a bridge girder first begins to reduce the flow area of the channel.

Low Hazard Zone - The area between the high hazard zone and the maximum extent of the 100-year frequency flood where the potential for loss of life and property damage is low.

Natural Values of Flood Plains - The desirable qualities of, or functions served by, flood plains including, but not limited to: water resources values (e.g. -- moderation of floods, water quality maintenance, and ground water recharge); living resource values (e.g. -- fish, wildlife, plant resources, and habitat); cultural resource values (e.g. -- open space, natural beauty, scientific study, outdoor education, and recreation); and cultivated resources values (e.g. -- agricultural, aquacultural, and forestry.)

NGVD - National Geodetic Vertical Datum, formerly Mean Sea Level (MSL) 1929.

Nonstructural Measures - All flood plain management measures except structural flood control works. Examples of nonstructural measures are flood warning and preparedness systems, relocation, floodproofing, regulation, land acquisition, and public investment policy.

Palustrine - Pertaining to material growing or deposited in a marsh or marsh-like environment.

Relocation - Moving a building from a flood-prone area by physically placing it on a vehicle and transporting it from the flood plain.

Road Overflow - The elevation of the point at which water first starts to flow over a road.

Shoreland Areas - Land within 250 feet of the normal high water mark of any pond, river, or salt water body, including a major portion of the flood plain.

Station - Distance in feet along the centerline of the existing channel, increasing in an upstream direction.

Structural Measure - Flood control works such as dams and reservoirs, dikes and floodwalls, channel alterations, and diversion channels which are designed to keep water away from specific developments or populated areas, or to reduce flooding in such areas.

Water Table - The upper surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere. The top of the zone of saturation of soil or rock.

Wetland - Areas that have a predominance of hydric soils and that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions.

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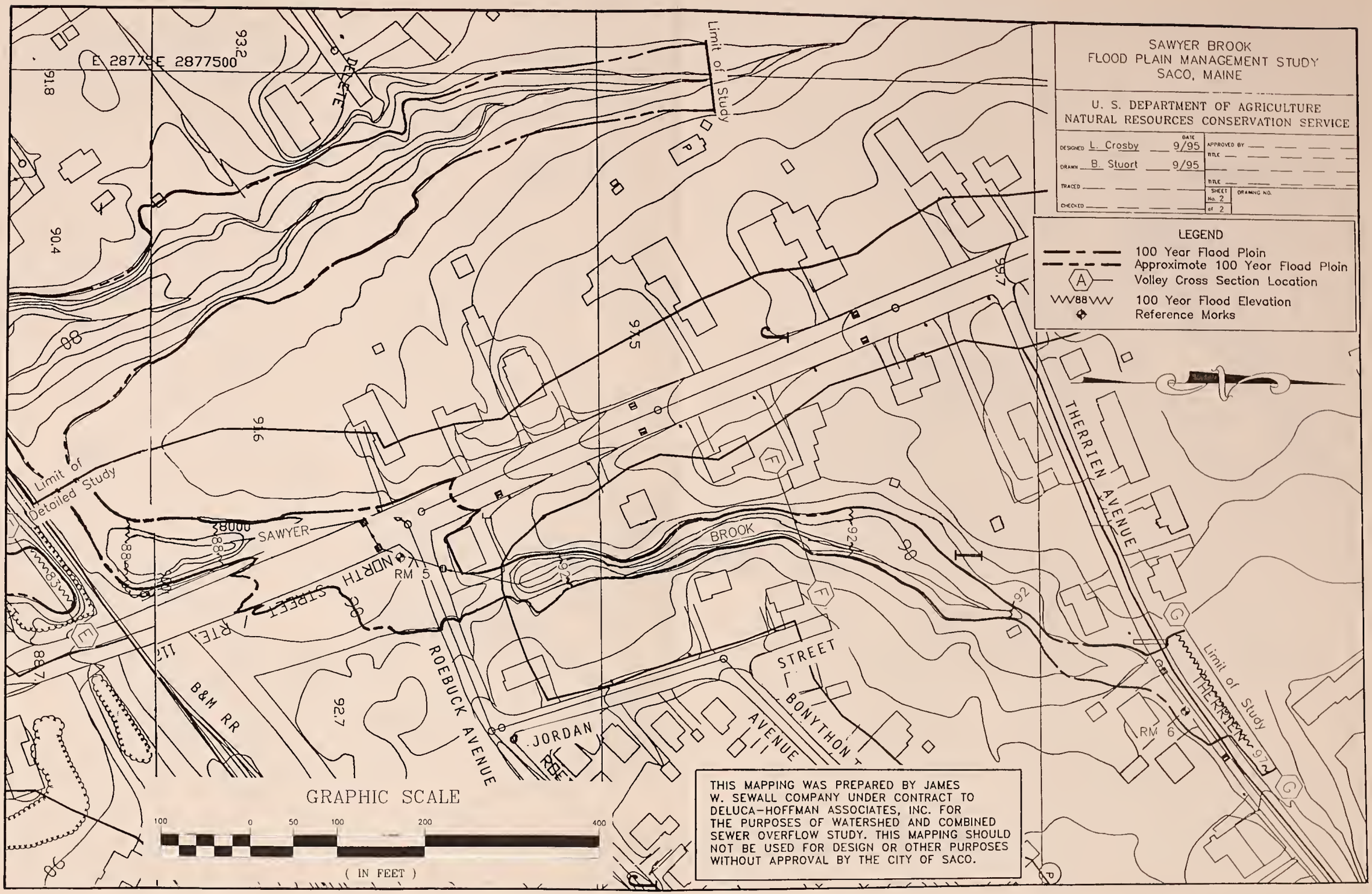
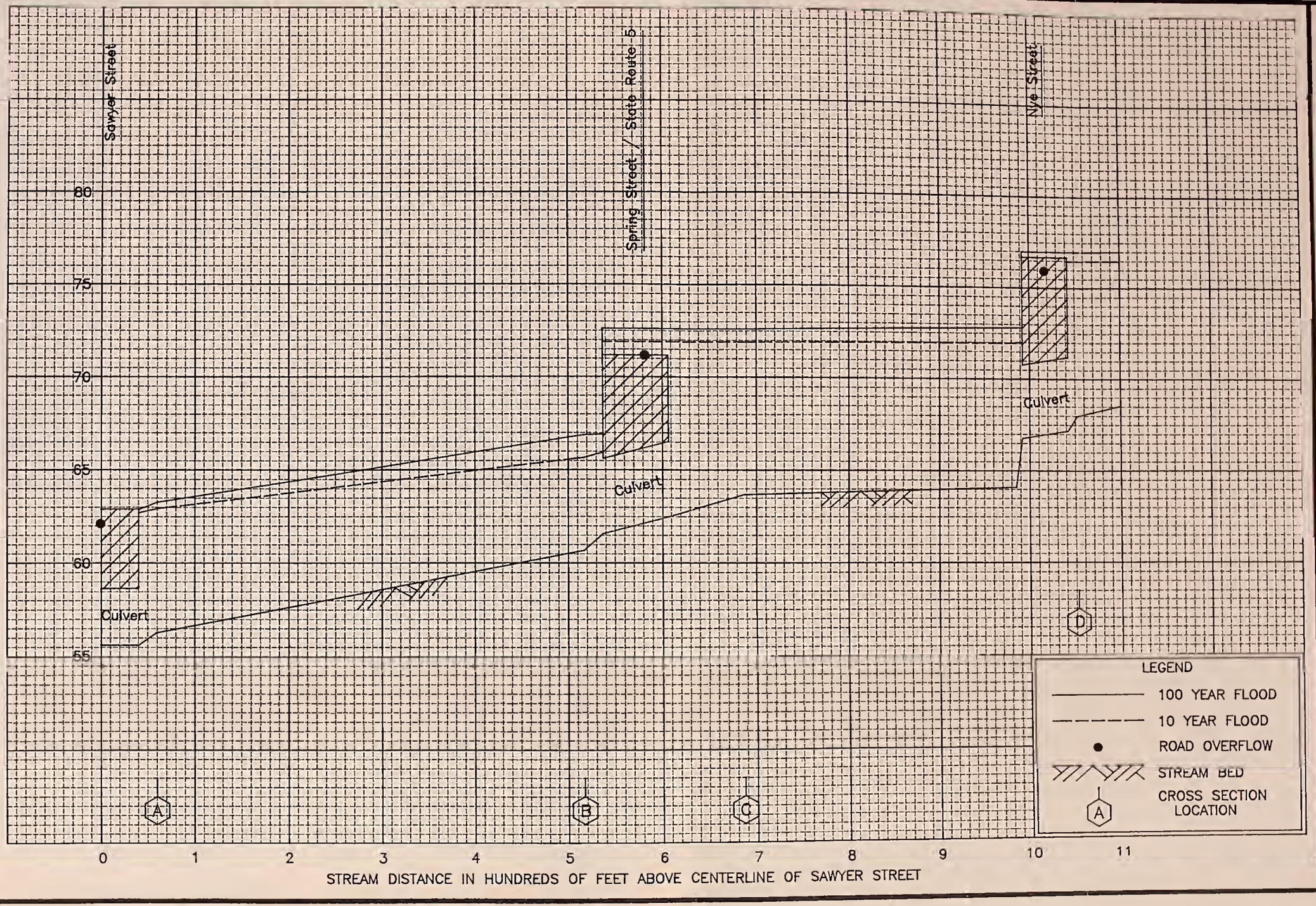
APPENDIX A

Flood Plain Maps


SAWYER BROOK
FLOOD PLAIN MANAGEMENT STUDY
SACO, MAINE
U. S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
DESIGNED L. Crosby 9/95
DRAWN B. Stuort 9/95
TRACED
CHECKED
APPROVED BY
TITLE
SHEET No. 2 of 2
DRAWING NO.
LEGEND
100 Year Flood Plain
Approximate 100 Year Flood Plain
Valley Cross Section Location
100 Year Flood Elevation
Reference Marks
E 2877500
Limit of Study
Limit of Detailed Study
SAWYER BROOK
NORTH STREET / RTE 112
ROEBUCK AVENUE
JORDAN AVENUE
BONYTHON STREET
THERRIEN AVENUE
B&M RR
RM 5
RM 6
GRAPHIC SCALE
100 0 50 100 200 400
(IN FEET)
THIS MAPPING WAS PREPARED BY JAMES W. SEWALL COMPANY UNDER CONTRACT TO DELUCA-HOFFMAN ASSOCIATES, INC. FOR THE PURPOSES OF WATERSHED AND COMBINED SEWER OVERFLOW STUDY. THIS MAPPING SHOULD NOT BE USED FOR DESIGN OR OTHER PURPOSES WITHOUT APPROVAL BY THE CITY OF SACO.

APPENDIX B

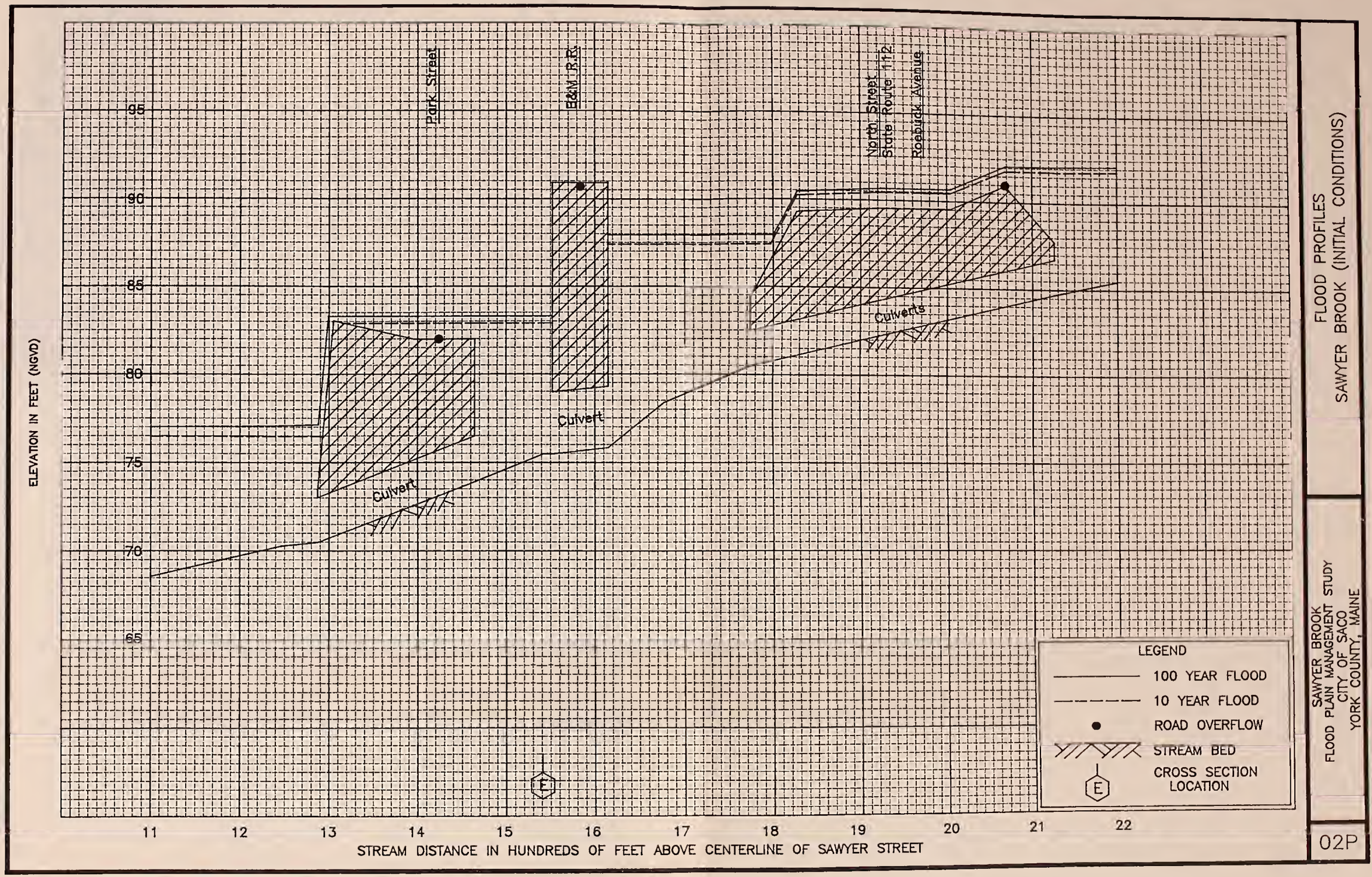
Flood Profiles

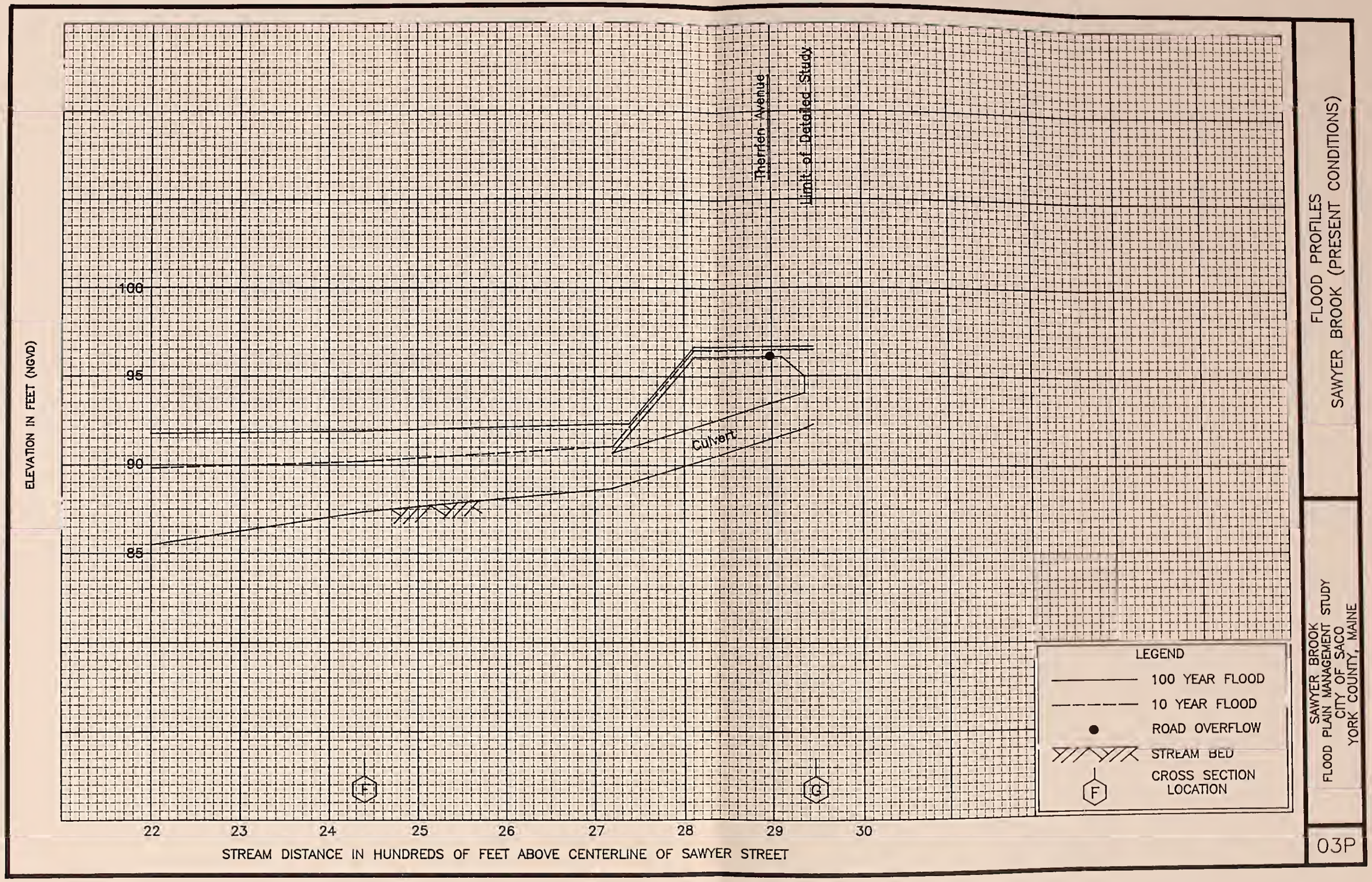


FLOOD PROFILES
SAWYER BROOK (INITIAL CONDITIONS)

SAWYER BROOK
FLOOD PLAIN MANAGEMENT STUDY
CITY OF SACO
YORK COUNTY, MAINE

01P


Park Street
E&M R.R.
North Street
State Route 112
Roebuck Avenue
Culvert
Culvert
Culverts
95
90
85
80
75
70
65
ELEVATION IN FEET (NGVD)
11
12
13
14
15
16
17
18
19
20
21
22
STREAM DISTANCE IN HUNDREDS OF FEET ABOVE CENTERLINE OF SAWYER STREET
LEGEND
100 YEAR FLOOD
10 YEAR FLOOD
ROAD OVERFLOW
STREAM BED
CROSS SECTION LOCATION
E
FLOOD PROFILES
SAWYER BROOK (INITIAL CONDITIONS)
SAWYER BROOK
FLOOD PLAIN MANAGEMENT STUDY
CITY OF SACO
YORK COUNTY, MAINE
02P



FLOOD PROFILES
SAWYER BROOK (PRESENT CONDITIONS)

SAWYER BROOK
FLOOD PLAIN MANAGEMENT STUDY
CITY OF SACO
YORK COUNTY, MAINE

03P

APPENDIX C

Hydrologic and Hydraulic Alternatives

ORIGINAL CONDITIONS

SUMMER 1993

AUGUST 1995 -- **W/ North Street / Roebuck Avenue culvert**

ALTERNATIVES <u>WITHOUT</u> NEW SPRING STREET CULVERT

ALTERNATIVE 1 -- **Pass 25-Year**

ALTERNATIVE 2 -- **Pass 100-Year**

ALTERNATIVE 3 -- **Industrialize G, H, X**

ALTERNATIVE 4 -- **Divert G, H, X**

ALTERNATIVES <u>WITH</u> NEW SPRING STREET CULVERT

ALTERNATIVE 5 -- **W/ August 1995 Conditions**

ALTERNATIVE 6 -- **Pass 25-Year**

ALTERNATIVE 7 -- **Pass 100-Year**

ALTERNATIVE 8 -- **Industrialize G, H, X**

ALTERNATIVE 9 -- **Industrialize G, H, X; Pass 25-Year**

ALTERNATIVE 10 -- **Industrialize G, H, X; Pass 100-Year**

ALTERNATIVE 11 -- **Divert G, H, X**

ALTERNATIVE 12 -- **Divert G, H, X; Pass 25-Year**

ALTERNATIVE 13 -- **Divert G, H, X; Pass 100-Year**

SUMMER 1993 CONDITIONS

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- one 48" diameter CMP culvert
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- one 24" diameter CMP culvert
- Therrien Avenue -- one 24" diameter RCP culvert

FLOOD ELEVATIONS (NGVD) -- SUMMER 1993 CONDITIONS
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.5	62.6	62.7	62.7	62.8	62.8	62.9
Spring Street	62.5	66.5	71.2	66.6	70.6	71.9	72.2	72.4	72.6	72.9
Nye Street	67.2	71.2	75.9	71.7	75.2	76.5	76.7	76.9	77.0	77.2
Park Street	73.9	76.4	82.0	79.7	82.7	82.9	83.1	83.2	83.3	83.5
B&M Railroad	75.8	79.3	90.7	81.1	87.0	87.4	87.6	87.8	87.9	88.1
Roebuck Avenue	84.7	86.7	90.9	91.4	91.7	91.8	92.0	92.1	92.1	92.3
Therrien Avenue	92.1	94.1	96.1	95.7	96.5	96.6	96.6	96.7	96.8	96.9

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- SUMMER 1993 CONDITIONS
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	75	140	190	255	305	355	460
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

AUGUST 1995 CONDITIONS

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- one 48" diameter CMP culvert
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- **TWO NEW 36" DIAMETER RCP CULVERTS**
- Therrien Avenue -- one 24" diameter RCP culvert

FLOOD ELEVATIONS (NGVD) -- AUGUST 1995 CONDITIONS
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.5	62.6	62.7	62.7	62.8	62.8	62.9
Spring Street	62.5	66.5	71.2	66.6	70.6	71.9	72.2	72.4	72.6	72.9
Nye Street	67.2	71.2	75.9	71.7	75.2	76.5	76.7	76.9	77.0	77.2
Park Street	73.9	76.4	82.0	79.7	82.7	82.9	83.1	83.2	83.3	83.5
B&M Railroad	75.8	79.3	90.7	81.1	87.0	87.4	87.6	87.8	87.9	88.1
Roebuck Avenue	84.1	87.1	90.9	86.2	88.3	89.7	91.3	91.5	91.7	91.9
Therrien Avenue	92.1	94.1	96.1	95.7	96.4	96.5	96.6	96.7	96.7	96.9

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- AUGUST 1995 CONDITIONS
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	75	140	190	255	305	355	460
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 1

PASS 25-YEAR FLOOD TO SAWYER STREET INLET WITHOUT OVERTOPPING ROADS UPSTREAM

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- **ONE NEW 66" DIAMETER CMP CULVERT**
- Nye Street -- **ONE NEW 66" DIAMETER CMP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER CMP CULVERT**
- B&M Railroad -- **ONE NEW 3.5' HIGH BY 3.5' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert plus **TWO NEW 30" DIAMETER CMP CULVERTS**

FLOOD ELEVATIONS (NGVD) -- ALTERNATIVE 1
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.5	62.6	62.7	62.7	62.8	62.8	62.9
Spring Street	62.5	68.0	71.2	65.8	67.4	69.2	70.9	71.8	72.1	72.5
Nye Street	67.2	72.7	75.9	71.0	72.6	73.9	75.5	76.3	76.6	76.9
Park Street	73.9	78.4	82.0	76.4	77.5	78.3	79.9	82.3	82.7	83.1
B&M Railroad	75.8	79.3	90.7	78.4	79.8	81.1	83.1	86.8	87.3	87.7
Roebuck Avenue	84.1	87.1	90.9	86.2	87.0	87.6	88.4	91.4	91.7	91.9
Therrien Avenue	92.1	94.1	96.1	93.6	94.3	94.9	95.9	96.4	96.6	96.7

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 1
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	75	140	190	255	305	355	460
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 2

PASS 100-YEAR FLOOD TO SAWYER STREET INLET WITHOUT OVERTOPPING ROADS UPSTREAM

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- **ONE NEW 78" DIAMETER RCP CULVERT**
- Nye Street -- **ONE NEW 78" DIAMETER RCP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER RCP CULVERT**
- B&M Railroad -- **ONE NEW 4.0' HIGH BY 4.0' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- **ONE NEW 3.0' HIGH BY 6.0' WIDE RC BOX CULVERT**
- Therrien Avenue -- **ONE NEW 2.0' HIGH BY 8.0' WIDE RC BOX CULVERT**

FLOOD ELEVATIONS (NGVD) -- ALTERNATIVE 2
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.5	62.6	62.7	62.7	62.8	62.8	62.9
Spring Street	62.5	69.0	71.2	65.5	66.9	67.7	68.7	69.6	70.6	71.9
Nye Street	67.2	73.7	75.9	70.3	71.6	72.5	73.4	74.3	75.3	76.5
Park Street	73.9	78.4	82.0	76.3	77.4	78.1	79.0	79.9	81.0	82.6
B&M Railroad	75.8	79.8	90.7	78.2	79.4	80.3	81.6	82.7	84.5	87.4
Roebuck Avenue	84.1	87.1	90.9	85.8	86.6	87.2	88.1	88.8	89.8	91.7
Therrien Avenue	92.1	94.1	96.1	93.2	93.7	94.1	94.7	95.2	95.8	96.4

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 2
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	75	140	190	255	305	355	460
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 3

INDUSTRIALIZE SUBWATERSHEDS G, H, AND X

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- one 48" diameter CMP culvert
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert
- **INDUSTRIALIZE SUBWATERSHEDS G, H, AND X**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 3
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.6	62.7	62.7	62.8	62.9	62.9	63.0
Spring Street	62.5	66.5	71.2	69.3	71.9	72.2	72.4	72.6	72.8	73.0
Nye Street	67.2	71.2	75.9	73.9	76.5	76.7	76.9	77.0	77.2	77.4
Park Street	73.9	76.4	82.0	82.7	83.0	83.1	83.3	83.4	83.5	83.7
B&M Railroad	75.8	79.3	90.7	86.9	87.5	87.7	87.9	88.0	88.1	88.3
Roebuck Avenue	84.1	87.1	90.9	88.2	90.7	91.4	91.7	91.9	92.0	92.2
Therrien Avenue	92.1	94.1	96.1	96.5	96.6	96.7	96.8	96.8	96.9	97.0

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 3
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	164	120	190	240	310	365	415	525
Spring Street	162	120	190	240	310	365	415	525
Nye Street	159	120	190	240	310	365	415	525
Park Street	86	80	120	145	180	215	240	295
B&M Railroad	85	80	120	145	180	215	240	295
Roebuck Avenue	82	80	120	145	180	210	240	295
Therrien Avenue	57	70	100	115	140	165	185	220

ALTERNATIVE 4

DIVERT SUBWATERSHEDS G, H, AND X

- Sawyer Street -- one 36" diameter CMP culvert at inlet
- Spring Street -- one 48" diameter CMP culvert
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- **DIVERT SUBWATERSHEDS G, H, AND X FROM WATERSHED**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 4
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Sawyer Street	55.6	58.6	62.1	62.4	62.5	62.6	62.6	62.7	62.7	62.8
Spring Street	62.5	66.5	71.2	65.7	67.7	69.7	71.7	72.0	72.2	72.4
Nye Street	67.2	71.2	75.9	70.8	72.4	74.1	76.3	76.5	76.7	76.9
Park Street	73.9	76.4	82.0	75.7	76.5	79.2	82.4	82.5	82.6	82.8
B&M Railroad	75.8	79.3	90.7	77.8	78.8	80.2	84.1	84.9	85.8	87.1
Roebuck Avenue	84.1	87.1	90.9	85.0	85.5	85.9	86.2	86.4	86.6	88.4
Therrien Avenue	1/	1/	1/	--	--	--	--	--	--	--

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 4
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Sawyer Street	108	55	95	130	170	205	235	305
Spring Street	105	55	95	130	170	205	235	305
Nye Street	102	50	90	125	165	195	230	295
Park Street	29	15	25	30	45	50	60	80
B&M Railroad	28	15	25	30	45	50	60	80
Roebuck Avenue	25	10	20	30	40	45	55	70
Therrien Av. 1/	0	0	0	0	0	0	0	0

1/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

ALTERNATIVE 5

INSTALL NEW 100-YEAR SPRING STREET OUTLET; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert

FLOOD ELEVATIONS (NGVD) -- ALTERNATIVE 5
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.0	71.2				66.5		69.1	
Nye Street	67.2	71.2	75.9				76.7		77.0	
Park Street	73.9	76.4	82.0				83.1		83.3	
B&M Railroad	75.8	79.3	90.7				87.6		87.9	
Roebuck Avenue	84.1	87.1	90.9				91.3		91.7	
Therrien Avenue	92.1	94.1	96.1				96.6		96.8	

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 5
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	115	200	270	360	430	505	655
South Street	215	105	185	250	335	400	465	600
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 6

INSTALL NEW 100-YEAR SPRING STREET OUTLET; PASS 25-YEAR FLOOD TO IT WITHOUT OVERTOPPING ROADS UPSTREAM; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 66" DIAMETER CMP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER CMP CULVERT**
- B&M Railroad -- **ONE NEW 3.5' HIGH BY 3.5' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert plus **TWO NEW 30" DIAMETER CMP CULVERTS**

FLOOD ELEVATIONS (NGVD) -- ALTERNATIVE 6
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.0	71.2				66.5		69.1	
Nye Street	67.2	72.7	75.9				75.5		76.6	
Park Street	73.9	78.4	82.0				79.9		82.7	
B&M Railroad	75.8	79.3	90.7				83.0		87.3	
Roebuck Avenue	84.1	87.1	90.9				88.4		91.7	
Therrien Avenue	92.1	94.1	96.1				95.9		96.5	

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 6
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	115	200	270	360	430	505	655
South Street	215	105	185	250	335	400	465	600
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 7

INSTALL NEW 100-YEAR SPRING STREET OUTLET; PASS 100-YEAR FLOOD TO IT WITHOUT OVERTOPPING ROADS UPSTREAM; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 78" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 78" DIAMETER RCP CULVERT**
- Park Street -- **ONE NEW 54" DIAMETER RCP CULVERT**
- B&M Railroad -- **ONE NEW 4.0' HIGH BY 4.0' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- **ONE NEW 3.0' HIGH BY 6.0' WIDE RC BOX CULVERT**
- Therrien Avenue -- **NEW 2.0' HIGH BY 8.0' WIDE RC BOX CULVERT**

FLOOD ELEVATIONS (NGVD) -- ALTERNATIVE 7
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.0	71.2				66.5		69.1	
Nye Street	67.2	73.7	75.9				73.4		75.3	
Park Street	73.9	78.4	82.0				79.0		81.0	
B&M Railroad	75.8	79.8	90.7				81.6		84.6	
Roebuck Avenue	84.1	87.1	90.9				88.1		89.8	
Therrien Avenue	92.1	94.1	96.1				94.7		95.8	

PEAK DISCHARGES (CFS) -- ALTERNATIVE 7
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	115	200	270	360	430	505	655
South Street	215	105	185	250	335	400	465	600
Spring Street	162	75	140	190	255	305	355	460
Nye Street	159	75	140	190	255	305	355	460
Park Street	86	35	70	95	130	155	180	235
B&M Railroad	85	35	70	95	130	155	180	235
Roebuck Avenue	82	35	65	95	125	150	175	230
Therrien Avenue	57	25	50	65	90	110	125	165

ALTERNATIVE 8

INDUSTRIALIZE WATERSHEDS G, H, AND X; INSTALL NEW 100-YEAR SPRING STREET OUTLET; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 84" TO 90" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- Therrien Avenue -- one 24" diameter RCP culvert
- **INDUSTRIALIZE SUBWATERSHEDS G, H, AND X**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 8
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.5	71.2				66.8		71.1	
Nye Street	67.2	71.2	75.9				76.8		77.1	
Park Street	73.9	76.4	82.0				83.3		83.5	
B&M Railroad	75.8	79.3	90.7				87.9		88.1	
Roebuck Avenue	84.1	87.1	90.9				91.7		92.0	
Therrien Avenue	92.1	94.1	96.1				96.8		96.9	

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 8
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	160	250	320	415	495	570	720
South Street	215	155	235	305	390	460	530	665
Spring Street	162	120	190	240	310	365	415	525
Nye Street	159	120	190	240	310	365	415	525
Park Street	86	80	120	145	180	215	240	295
B&M Railroad	85	80	120	145	180	215	240	295
Roebuck Avenue	82	80	120	145	180	210	240	295
Therrien Avenue	57	70	100	115	140	165	185	220

ALTERNATIVE 9

INDUSTRIALIZE SUBWATERSHEDS G, H, AND X; INSTALL NEW 100-YEAR SPRING STREET OUTLET; PASS 25-YEAR FLOOD WITHOUT OVERTOPPING ROADS UPSTREAM; ADD SUBWATERSHED Y

- **INDUSTRIALIZE SUBWATERSHEDS G, H, AND X**
- Spring Street -- **ONE NEW 84" TO 90" DIAMETER RCP CULVERT**
- Nye Street -- **ONE NEW 78" DIAMETER CMP CULVERT**
- Park Street -- **ONE NEW 60" DIAMETER CMP CULVERT**
- B&M Railroad -- **ONE NEW 4.0' HIGH BY 4.0' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts plus **ONE NEW 36" DIAMETER RCP CULVERT**
- Therrien Avenue -- one 24" diameter RCP culvert plus **THREE NEW 30" DIAMETER CMP CULVERTS**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 9
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.5	71.2				66.8		71.1	
Nye Street	67.2	73.7	75.9				75.5		76.5	
Park Street	73.9	78.9	82.0				80.9		82.8	
B&M Railroad	75.8	79.8	90.7				84.5		87.5	
Roebuck Avenue	84.1	87.1	90.9				88.7		91.7	
Therrien Avenue	92.1	94.1	96.1				95.7		96.5	

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 9
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	160	250	320	415	495	570	720
South Street	215	155	235	305	390	460	530	665
Spring Street	162	120	190	240	310	365	415	525
Nye Street	159	120	190	240	310	365	415	525
Park Street	86	80	120	145	180	215	240	295
B&M Railroad	85	80	120	145	180	215	240	295
Roebuck Avenue	82	80	120	145	180	210	240	295
Therrien Avenue	57	70	100	115	140	165	185	220

ALTERNATIVE 10

INDUSTRIALIZE SUBWATERSHEDS G, H, AND X; INSTALL NEW 100-YEAR SPRING STREET OUTLET; PASS 100-YEAR FLOOD WITHOUT OVERTOPPING ROADS UPSTREAM; ADD SUBWATERSHED Y

- **INDUSTRIALIZE SUBWATERSHEDS G, H, AND X**
- Spring Street -- **ONE NEW 84" TO 90" DIAMETER RCP CULVERT**
- Nye Street -- **ONE NEW 84" DIAMETER RCP CULVERT**
- Park Street -- **ONE NEW 60" DIAMETER RCP CULVERT**
- B&M Railroad -- **ONE NEW 4.5' HIGH BY 4.5' WIDE RC BOX CULVERT**
- North Street / Roebuck Avenue -- **ONE NEW 3.0' HIGH BY 7.5' WIDE RC BOX CULVERT**
- Therrien Avenue -- **ONE NEW 2.0' HIGH BY 11.0' WIDE RC BOX CULVERT**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 10
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	69.5	71.2				66.8		71.1	
Nye Street	67.2	74.2	75.9				74.0		75.7	
Park Street	73.9	78.9	82.0				79.9		81.9	
B&M Railroad	75.8	80.3	90.7				82.4		85.8	
Roebuck Avenue	84.1	87.1	90.9				88.5		90.8	
Therrien Avenue	92.1	94.1	96.1				94.9		96.1	

PEAK DISCHARGES (CFS) -- ALTERNATIVE 10
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	250	160	250	320	415	495	570	720
South Street	215	155	235	305	390	460	530	665
Spring Street	162	120	190	240	310	365	415	525
Nye Street	159	120	190	240	310	365	415	525
Park Street	86	80	120	145	180	215	240	295
B&M Railroad	85	80	120	145	180	215	240	295
Roebuck Avenue	82	80	120	145	180	210	240	295
Therrien Avenue	57	70	100	115	140	165	185	220

ALTERNATIVE 11

INSTALL NEW 100-YEAR SPRING STREET OUTLET; DIVERT SUBWATERSHEDS G, H, AND X OUT OF THE WATERSHED; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 72" TO 78" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- one 48" diameter CMP culvert
- Park Street -- one 30" diameter CMP culvert
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- **DIVERT SUBWATERSHEDS G, H, AND X FROM WATERSHED**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 11
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	68.5	71.2	--	--	--	66.0	--	70.2	--
Nye Street	67.2	71.2	75.9	--	--	--	76.2	--	76.6	--
Park Street	73.9	76.4	82.0	--	--	--	82.4	--	82.6	--
B&M Railroad	75.8	79.3	90.7	--	--	--	84.1	--	85.8	--
Roebuck Avenue	84.1	87.1	90.9	--	--	--	86.2	--	86.6	--
Therrien Avenue	1/	1/	1/	--	--	--	--	--	--	--

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 11
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	193	95	160	215	285	340	400	510
South Street	158	90	145	190	255	300	350	450
Spring Street	105	55	95	130	170	205	235	305
Nye Street	102	50	90	125	165	195	230	295
Park Street	29	15	25	30	45	50	60	80
B&M Railroad	28	15	25	30	45	50	60	80
Roebuck Avenue	25	10	20	30	40	45	55	70
Therrien Av. 1/	0	0	0	0	0	0	0	0

1/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

ALTERNATIVE 12

INSTALL NEW 100-YEAR SPRING STREET CULVERT; DIVERT SUBWATERSHEDS PASS 25-YEAR FLOOD WITHOUT OVERTOPPING ROADS UPSTREAM; G, H, AND X OUT OF THE WATERSHED; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 72" TO 78" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 54" DIAMETER CMP CULVERT**
- Park Street -- **ONE NEW 36" DIAMETER CMP CULVERT**
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- **DIVERT SUBWATERSHEDS G, H, AND X FROM WATERSHED**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 12
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	68.5	71.2	--	--	--	66.0	--	70.2	--
Nye Street	67.2	71.2	75.9	--	--	--	74.6	--	76.4	--
Park Street	73.9	76.4	82.0	--	--	--	78.1	--	82.3	--
B&M Railroad	75.8	79.3	90.7	--	--	--	80.1	--	85.4	--
Roebuck Avenue	84.1	87.1	90.9	--	--	--	86.2	--	86.6	--
Therrien Avenue	1/	1/	1/	--	--	--	--	--	--	--

Shading indicates road overtopping.

PEAK DISCHARGES (CFS) -- ALTERNATIVE 12
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	193	95	160	215	285	340	400	510
South Street	158	90	145	190	255	300	350	450
Spring Street	105	55	95	130	170	205	235	305
Nye Street	102	50	90	125	165	195	230	295
Park Street	29	15	25	30	45	50	60	80
B&M Railroad	28	15	25	30	45	50	60	80
Roebuck Avenue	25	10	20	30	40	45	55	70
Therrien Av. 1/	0	0	0	0	0	0	0	0

1/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

ALTERNATIVE 13

INSTALL NEW 100-YEAR SPRING STREET CULVERT; DIVERT SUBWATERSHEDS PASS 100-YEAR FLOOD WITHOUT OVERTOPPING ROADS UPSTREAM; G, H, AND X OUT OF THE WATERSHED; ADD SUBWATERSHED Y

- **DIVERT NEW SUBWATERSHED Y TO NEW SPRING STREET OUTLET**
- Spring Street -- **ONE NEW 72" TO 78" DIAMETER RCP CULVERT TO SACO RIVER**
- Nye Street -- **ONE NEW 60" DIAMETER RCP CULVERT**
- Park Street -- **ONE NEW 30" DIAMETER RCP CULVERT**
- B&M Railroad -- one 3.5' high by 2.0' wide cut stone box culvert
- North Street / Roebuck Avenue -- two 36" diameter RCP culverts
- **DIVERT SUBWATERSHEDS G, H, AND X FROM WATERSHED**

FLOOD ELEVATIONS (NGVD) --ALTERNATIVE 13
SAWYER BROOK WATERSHED, SACO, MAINE

HEADWATER ELEVATION AT	CHANNEL BOTTOM	LOW CHORD	ROAD OVER-FLOW	FLOOD FREQUENCY IN YEARS						
				2	5	10	25	50	100	500
Spring Street	62.5	68.5	71.2	--	--	--	66.0	--	70.2	--
Nye Street	67.2	71.2	75.9	--	--	--	72.9	--	74.8	--
Park Street	73.9	76.4	82.0	--	--	--	78.0	--	81.0	--
B&M Railroad	75.8	79.3	90.7	--	--	--	80.2	--	84.3	--
Roebuck Avenue	84.1	87.1	90.9	--	--	--	86.2	--	86.6	--
Therrien Avenue	1/	1/	1/	--	--	--	--	--	--	--

PEAK DISCHARGES (CFS) -- ALTERNATIVE 13
SAWYER BROOK WATERSHED, SACO, MAINE

DISCHARGE AT INLET OF	D. A. ACRES	FLOOD FREQUENCY IN YEARS						
		2	5	10	25	50	100	500
Saco River	193	95	160	215	285	340	400	510
South Street	158	90	145	190	255	300	350	450
Spring Street	105	55	95	130	170	205	235	305
Nye Street	102	50	90	125	165	195	230	295
Park Street	29	15	25	30	45	50	60	80
B&M Railroad	28	15	25	30	45	50	60	80
Roebuck Avenue	25	10	20	30	40	45	55	70
Therrien Av. 1/	0	0	0	0	0	0	0	0

1/ No discharge through Therrien Avenue culvert to Sawyer Brook with diversion of subwatersheds G, H, and X. Therrien Avenue becomes an upstream watershed divide for subwatershed H.

APPENDIX D

Culvert Replacement Cost Estimates

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

SPRING STREET OUTLET - INDUSTRIALIZING SUBAREAS G, H, AND X

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization (5% Constr Cost)	1.0	JOB	LS	$75,846.00
2	Sed & Erosion Control (2% Constr Cost)	1.0	JOB	LS	$30,338.00
3	Traffic Control	1.0	JOB	LS	$50,000.00
4	Inlet Structure at Sawyer Brook	1.0	JOB	LS	$30,000.00
5	Inlet Structure Trash Rack	1.0	JOB	LS	$15,000.00
6	Cofferdam at Outlet	1.0	JOB	LS	$80,000.00
7	Headwall at Saco River	1.0	JOB	LS	$25,000.00
8	Manholes Transition Structures	5.0	EA	$16,000.00	$80,000.00
9	90-in Reinf Concrete Pipe	1125.0	LF	$320.00	$360,000.00
10	84-in Reinf Concrete Pipe	1290.0	LF	$261.00	$336,690.00
11	Shoring	1.0	JOB	LS	$100,000.00
12	Trench Excavation and Backfill	2435.0	LF	$110.00	$267,850.00
13	Trench Rock Excavation (Allowance)	800.0	CY	$80.00	$64,000.00
14	Pipe Bedding	2435.0	LF	$25.00	$60,875.00
15	Spoil Disposal	2435.0	LF	$11.00	$26,785.00
16	Open Channel Reconstr (Sawyer Brk)	30.0	LF	$100.00	$3,000.00
17	Paving	9800.0	SY	$6.40	$62,720.00
18	Seeding and Mulching	1.0	AC	$5,000.00	$5,000.00
19	Exist Utility Reconstr (15% Constr Cost)	1.0	JOB	LS	$227,538.00
20	Contingency (15% Constr Cost)	1.0	JOB	LS	$227,538.00
	Total Construction				$2,128,180.00
	Design and Contract Administration (15% Total Constr Cost)				$319,227.00
				Total Cost	$2,447,407.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

SPRING STREET OUTLET - PRESENT CONDITIONS

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization (5% Constr Cost)	1.0	JOB	LS	$74,547.00
2	Sed & Erosion Control (2% Constr Cost)	1.0	JOB	LS	$29,819.00
3	Traffic Control	1.0	JOB	LS	$50,000.00
4	Inlet Structure at Sawyer Brook	1.0	JOB	LS	$30,000.00
5	Inlet Structure Trash Rack	1.0	JOB	LS	$15,000.00
6	Cofferdam at Outlet	1.0	JOB	LS	$80,000.00
7	Headwall at Saco River	1.0	JOB	LS	$25,000.00
8	Manhole Transition Structures	5.0	EA	$16,000.00	$80,000.00
9	90-in Reinf Concrete Pipe	925.0	LF	$320.00	$296,000.00
10	84-in Reinf Concrete Pipe	1160.0	LF	$261.00	$302,760.00
11	78-in Reinf Concrete Pipe	327.0	LF	$220.00	$71,940.00
12	Shoring	1.0	JOB	LS	$100,000.00
13	Trench Excavation and Backfill	2435.0	LF	$110.00	$267,850.00
14	Trench Rock Excavation (Allowance)	800.0	CY	$80.00	$64,000.00
15	Pipe Bedding	2435.0	LF	$25.00	$60,875.00
16	Spoil Disposal	2435.0	LF	$11.00	$26,785.00
17	Open Channel Reconstr (Sawyer Brk)	30.0	LF	$100.00	$3,000.00
18	Paving	9800.0	SY	$6.40	$62,720.00
19	Seeding and Mulching	1.0	AC	$5,000.00	$5,000.00
20	Exist Utility Reconstr (15% Constr Cost)	1.0	JOB	LS	$223,640.00
21	Contingency (15% Constr Cost)	1.0	JOB	LS	$223,640.00
	Total Construction				$2,092,576.00
	Design and Contract Administration (15% Total Constr Cost)				$313,886.00
				Total Cost	$2,406,462.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

SPRING STREET - ONE 5.5' DIAMETER CMP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,064.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$885.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	70.0	LF	$42.00	$2,940.00
5	Remove Existing Culvert	70.0	LF	$20.00	$1,400.00
6	Headwall with Wingwalls	2.0	EA	$6,500.00	$13,000.00
7	Pipe Bedding	70.0	LF	$13.50	$945.00
8	Spoil Disposal	70.0	LF	$6.75	$473.00
9	66-in CMP	70.0	LF	$128.00	$8,960.00
10	Paving	120.0	SY	$6.40	$768.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$4,423.00
	Total Construction				$38,858.00
	Design and Contract Administration (15% Total Constr Cost)				$5,829.00
				Total Cost	$44,687.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

SPRING STREET - ONE 6.5' DIAMETER RCP CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,655.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,138.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	70.0	LF	$42.00	$2,940.00
5	Remove Existing Culvert	70.0	LF	$20.00	$1,400.00
6	Headwall with Wingwalls	2.0	EA	$7,500.00	$15,000.00
7	Pipe Bedding	70.0	LF	$13.50	$945.00
8	Spoil Disposal	70.0	LF	$6.75	$473.00
9	78-in RCP	70.0	LF	$220.00	$15,400.00
10	Paving	120.0	SY	$6.40	$768.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$5,689.00
	Total Construction				$49,408.00
	Design and Contract Administration (15% Total Constr Cost)				$7,411.00
				Total Cost	$56,819.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NYE STREET - ONE 5.5' DIAMETER CMP CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$1,754.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$752.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	50.0	LF	$42.00	$2,100.00
5	Remove Existing Culvert	50.0	LF	$20.00	$1,000.00
6	Headwall with Wingwalls	2.0	EA	$6,500.00	$13,000.00
7	Pipe Bedding	50.0	LF	$13.50	$675.00
8	Spoil Disposal	50.0	LF	$6.75	$338.00
9	66-in CMP	50.0	LF	$128.00	$6,400.00
10	Paving	85.0	SY	$6.40	$544.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$3,759.00
	Total Construction				$33,322.00
	Design and Contract Administration (15% Total Constr Cost)				$4,998.00
				Total Cost	$38,320.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NYE STREET - ONE 6.5' DIAMETER RCP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,027.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$869.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	50.0	LF	$48.00	$2,400.00
5	Remove Existing Culvert	50.0	LF	$20.00	$1,000.00
6	Headwall with Wingwalls	2.0	EA	$7,500.00	$15,000.00
7	Pipe Bedding	50.0	LF	$13.50	$675.00
8	Spoil Disposal	50.0	LF	$6.75	$338.00
9	78-in RCP	50.0	LF	$160.00	$8,000.00
10	Paving	85.0	SY	$6.40	$544.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$4,344.00
	Total Construction				$38,197.00
	Design and Contract Administration (15% Total Constr Cost)				$5,730.00
				Total Cost	$43,927.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NYE STREET - ONE 6.5' DIAMETER CMP CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,027.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$869.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	50.0	LF	$48.00	$2,400.00
5	Remove Existing Culvert	50.0	LF	$20.00	$1,000.00
6	Headwall with Wingwalls	2.0	EA	$7,500.00	$15,000.00
7	Pipe Bedding	50.0	LF	$13.50	$675.00
8	Spoil Disposal	50.0	LF	$6.75	$338.00
9	78-in CMP	50.0	LF	$160.00	$8,000.00
10	Paving	85.0	SY	$6.40	$544.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$4,344.00
	Total Construction				$38,197.00
	Design and Contract Administration (15% Total Constr Cost)				$5,730.00
				Total Cost	$43,927.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NYE STREET - ONE 7.0' DIAMETER RCP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,450.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,050.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	50.0	LF	$48.00	$2,400.00
5	Remove Existing Culvert	50.0	LF	$20.00	$1,000.00
6	Headwall with Wingwalls	2.0	EA	$8,000.00	$16,000.00
7	Pipe Bedding	50.0	LF	$13.50	$675.00
8	Spoil Disposal	50.0	LF	$6.75	$338.00
9	84-in RCP	50.0	LF	$261.00	$13,050.00
10	Paving	85.0	SY	$6.40	$544.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$5,251.00
	Total Construction				$45,758.00
	Design and Contract Administration (15% Total Constr Cost)				$6,864.00
				Total Cost	$52,622.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

PARK STREET - ONE 4.5' DIAMETER CMP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,511.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,076.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	177.0	LF	$25.00	$4,425.00
5	Remove Existing Culvert	177.0	LF	$15.00	$2,655.00
6	Headwall with Wingwalls	2.0	EA	$4,000.00	$8,000.00
7	Pipe Bedding	177.0	LF	$10.00	$1,770.00
8	Spoil Disposal	177.0	LF	$5.00	$885.00
9	54-in CMP	177.0	LF	$86.00	$15,222.00
10	Paving	300.0	SY	$6.40	$1,920.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$5,382.00
	Total Construction				$46,846.00
	Design and Contract Administration (15% Total Constr Cost)				$7,027.00
				Total Cost	$53,873.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

PARK STREET - ONE 4.5' DIAMETER RCP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,883.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,236.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	177.0	LF	$25.00	$4,425.00
5	Remove Existing Culvert	177.0	LF	$15.00	$2,655.00
6	Headwall with Wingwalls	2.0	EA	$4,000.00	$8,000.00
7	Pipe Bedding	177.0	LF	$10.00	$1,770.00
8	Spoil Disposal	177.0	LF	$5.00	$885.00
9	54-in RCP	177.0	LF	$116.00	$20,532.00
10	Paving	300.0	SY	$6.40	$1,920.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$6,178.00
	Total Construction				$53,484.00
	Design and Contract Administration (15% Total Constr Cost)				$8,023.00
				Total Cost	$61,507.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

PARK STREET - ONE 5.0' DIAMETER CMP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,794.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,197.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	177.0	LF	$25.00	$4,425.00
5	Remove Existing Culvert	177.0	LF	$15.00	$2,655.00
6	Headwall with Wingwalls	2.0	EA	$4,600.00	$9,200.00
7	Pipe Bedding	177.0	LF	$10.00	$1,770.00
8	Spoil Disposal	177.0	LF	$5.00	$885.00
9	60-in CMP	177.0	LF	$102.00	$18,054.00
10	Paving	300.0	SY	$6.40	$1,920.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$5,986.00
	Total Construction				$51,886.00
	Design and Contract Administration (15% Total Constr Cost)				$7,783.00
				Total Cost	$59,669.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

PARK STREET - ONE 5.0' DIAMETER RCP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$3,240.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,388.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	177.0	LF	$25.00	$4,425.00
5	Remove Existing Culvert	177.0	LF	$15.00	$2,655.00
6	Headwall with Wingwalls	2.0	EA	$4,600.00	$9,200.00
7	Pipe Bedding	177.0	LF	$10.00	$1,770.00
8	Spoil Disposal	177.0	LF	$5.00	$885.00
9	60-in RCP	177.0	LF	$138.00	$24,426.00
10	Paving	300.0	SY	$6.40	$1,920.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$6,942.00
	Total Construction				$59,851.00
	Design and Contract Administration (15% Total Constr Cost)				$8,978.00
				Total Cost	$68,829.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

B&M RAILROAD - ONE 3.5' HIGH x 3.5' WIDE RC BOX CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$3,519.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,508.00
3	Traffic Control	1.0	JOB	LS	$5,000.00
4	Railroad Insurance & Inspection Services	1.0	JOB	LS	$10,000.00
5	Trench Excavation and Backfill	63.0	LF	$92.00	$5,796.00
6	Remove Existing Culvert	63.0	LF	$50.00	$3,150.00
7	Headwall with Wingwalls	2.0	EA	$5,000.00	$10,000.00
8	Pipe Bedding	63.0	LF	$25.00	$1,575.00
9	3.5' x 3.5' RC Box Culvert	63.0	LF	$250.00	$15,750.00
10	Remove and Replace Ties & Rails	100.0	LF	$130.00	$13,000.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$7,541.00
	Total Construction				$77,839.00
	Design and Contract Administration (15% Total Constr Cost)				$11,676.00
				Total Cost	$89,515.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

B&M RAILROAD - ONE 4.0' HIGH x 4.0' WIDE RC BOX CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$3,828.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,640.00
3	Traffic Control	1.0	JOB	LS	$5,000.00
4	Railroad Insurance & Inspection Services	1.0	JOB	LS	$10,000.00
5	Trench Excavation and Backfill	63.0	LF	$92.00	$5,796.00
6	Remove Existing Culvert	63.0	LF	$50.00	$3,150.00
7	Headwall with Wingwalls	2.0	EA	$5,000.00	$10,000.00
8	Pipe Bedding	63.0	LF	$25.00	$1,575.00
9	4.0' x 4.0' RC Box Culvert	63.0	LF	$320.00	$20,160.00
10	Remove and Replace Ties & Rails	100.0	LF	$130.00	$13,000.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$8,202.00
	Total Construction				$83,351.00
	Design and Contract Administration (15% Total Constr Cost)				$12,503.00
				Total Cost	$95,854.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

B&M RAILROAD - ONE 4.5' HIGH x 4.5' WIDE RC BOX CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$4,092.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,754.00
3	Traffic Control	1.0	JOB	LS	$5,000.00
4	Railroad Insurance & Inspection Services	1.0	JOB	LS	$10,000.00
5	Trench Excavation and Backfill	63.0	LF	$92.00	$5,796.00
6	Remove Existing Culvert	63.0	LF	$50.00	$3,150.00
7	Headwall with Wingwalls	2.0	EA	$5,000.00	$10,000.00
8	Pipe Bedding	63.0	LF	$25.00	$1,575.00
9	4.5' x 4.5' RC Box Culvert	63.0	LF	$380.00	$23,940.00
10	Remove and Replace Ties & Rails	100.0	LF	$130.00	$13,000.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$8,769.00
	Total Construction				$88,076.00
	Design and Contract Administration (15% Total Constr Cost)				$13,211.00
				Total Cost	$101,287.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NORTH STREET / ROEBUCK AVENUE - TWO 3.0' DIAMETER RCP CULVERTS
PER DELUCA-HOFFMAN ASSOCIATES' PLAN

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$7,675.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$3,289.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	280.0	LF	$40.00	$11,200.00
5	Remove Existing Culvert	280.0	LF	$10.00	$2,800.00
6	Headwall with Wingwalls	2.0	EA	$6,500.00	$13,000.00
7	Headwall Grates	2.0	EA	$2,000.00	$4,000.00
8	Pipe Bedding	280.0	LF	$22.00	$6,160.00
9	Spoil Disposal	280.0	LF	$11.00	$3,080.00
10	36-in RCP Culvert	560.0	LF	$68.00	$38,080.00
11	Manhole Transition Structure	4.0	EA	$6,000.00	$24,000.00
12	Rock Riprap	80.0	CY	$35.00	$2,800.00
13	Paving	550.0	SY	$6.40	$3,520.00
14	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
15	Contingency (15% Constr Cost)	1.0	JOB	LS	$16,446.00
	Total Construction				$139,050.00
	Design and Contract Administration (15% Total Constr Cost)				$20,858.00
				Total Cost	$159,908.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NORTH STREET / ROEBUCK AVENUE - ONE 3.0' HIGH x 6.0' WIDE RC BOX CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$7,657.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$3,282.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	353.0	LF	$20.00	$7,060.00
5	Remove Existing Culvert	706.0	LF	$10.00	$7,060.00
6	Headwall with Wingwalls	2.0	EA	$4,600.00	$9,200.00
7	Pipe Bedding	353.0	LF	$11.00	$3,883.00
8	Spoil Disposal	353.0	LF	$5.50	$1,942.00
9	3.0' x 6.0' RC Box Culvert	353.0	LF	$200.00	$70,600.00
10	Manhole Transition Structure	1.0	EA	$8,000.00	$8,000.00
11	Paving	100.0	SY	$6.40	$640.00
12	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
13	Contingency (15% Constr Cost)	1.0	JOB	LS	$16,408.00
	Total Construction				$138,732.00
	Design and Contract Administration (15% Total Constr Cost)				$20,810.00
				Total Cost	$159,542.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NORTH STREET / ROEBUCK AVENUE - ONE 3.0' DIAMETER RCP CULVERT

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$4,002.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,715.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	353.0	LF	$16.00	$5,648.00
5	Remove Existing Culvert	706.0	LF	$10.00	$7,060.00
6	Headwall with Wingwalls	2.0	EA	$2,500.00	$5,000.00
7	Pipe Bedding	353.0	LF	$11.00	$3,883.00
8	Spoil Disposal	353.0	LF	$5.50	$1,942.00
9	36-in RCP Culvert	353.0	LF	$68.00	$24,004.00
10	Manhole Transition Structure	1.0	EA	$8,000.00	$8,000.00
11	Paving	100.0	SY	$6.40	$640.00
12	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
13	Contingency (15% Constr Cost)	1.0	JOB	LS	$8,577.00
	Total Construction				$73,471.00
	Design and Contract Administration (15% Total Constr Cost)				$11,021.00
				Total Cost	$84,492.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

NORTH STREET / ROEBUCK AVENUE - ONE 3.0' HIGH x 7.5' WIDE RC BOX CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$8,948.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$3,835.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	353.0	LF	$20.00	$7,060.00
5	Remove Existing Culvert	706.0	LF	$10.00	$7,060.00
6	Headwall with Wingwalls	2.0	EA	$5,000.00	$10,000.00
7	Pipe Bedding	353.0	LF	$11.00	$3,883.00
8	Spoil Disposal	353.0	LF	$5.50	$1,942.00
9	3.0' x 7.5' RC Box Culvert	353.0	LF	$250.00	$88,250.00
10	Manhole Transition Structure	1.0	EA	$8,000.00	$8,000.00
11	Paving	100.0	SY	$6.40	$640.00
12	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
13	Contingency (15% Constr Cost)	1.0	JOB	LS	$19,175.00
	Total Construction				$161,793.00
	Design and Contract Administration (15% Total Constr Cost)				$24,269.00
				Total Cost	$186,062.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

THERRIEN AVENUE - TWO 2.5' DIAMETER CMP CULVERTS

By: art

Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$2,444.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,048.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	216.0	LF	$13.50	$2,916.00
5	Remove Existing Culvert	216.0	LF	$10.00	$2,160.00
6	Headwall with Wingwalls	2.0	EA	$6,000.00	$12,000.00
7	Pipe Bedding	216.0	LF	$7.00	$1,512.00
8	Spoil Disposal	216.0	LF	$3.50	$756.00
9	30-in CMP	432.0	LF	$33.00	$14,256.00
10	Paving	50.0	SY	$6.40	$320.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$5,238.00
	Total Construction				$45,650.00
	Design and Contract Administration (15% Total Constr Cost)				$6,848.00
				Total Cost	$52,498.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

THERRIEN AVENUE - THREE 2.5' DIAMETER CMP CULVERTS

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$3,531.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,513.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	216.0	LF	$27.00	$5,832.00
5	Remove Existing Culvert	216.0	LF	$10.00	$2,160.00
6	Headwall with Wingwalls	2.0	EA	$8,000.00	$16,000.00
7	Pipe Bedding	216.0	LF	$11.00	$2,376.00
8	Spoil Disposal	216.0	LF	$5.50	$1,188.00
9	30-in CMP	648.0	LF	$33.00	$21,384.00
10	Paving	50.0	SY	$10.00	$500.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$7,566.00
	Total Construction				$65,050.00
	Design and Contract Administration (15% Total Constr Cost)				$9,758.00
				Total Cost	$74,808.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

THERRIEN AVENUE - ONE 2.0' HIGH x 8.0' WIDE RC BOX CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$4,378.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$1,876.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	216.0	LF	$27.00	$5,832.00
5	Remove Existing Culvert	216.0	LF	$10.00	$2,160.00
6	Headwall with Wingwalls	2.0	EA	$8,000.00	$16,000.00
7	Pipe Bedding	216.0	LF	$11.00	$2,376.00
8	Spoil Disposal	216.0	LF	$5.50	$1,188.00
9	2.0' x 8.0' RC Box Culvert	216.0	LF	$155.00	$33,480.00
10	Paving	50.0	SY	$10.00	$500.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$9,380.00
	Total Construction				$80,170.00
	Design and Contract Administration (15% Total Constr Cost)				$12,026.00
				Total Cost	$92,196.00

SAWYER BROOK FPMS
SACO, MAINE

COST ESTIMATE

THERRIEN AVENUE - ONE 2.0' HIGH x 11.0' WIDE RC BOX CULVERT

By: art Date: 11/15/95

Item No.	Work or Material	Quantity	Unit	Unit Cost	Amount
1	Mobilization, 7% Constr Cost	1.0	JOB	LS	$6,442.00
2	Sed & Erosion Control, 3% Constr Cost	1.0	JOB	LS	$2,761.00
3	Traffic Control	1.0	JOB	LS	$2,000.00
4	Trench Excavation and Backfill	216.0	LF	$34.00	$7,344.00
5	Remove Existing Culvert	216.0	LF	$10.00	$2,160.00
6	Headwall with Wingwalls	2.0	EA	$10,000.00	$20,000.00
7	Pipe Bedding	216.0	LF	$17.00	$3,672.00
8	Spoil Disposal	216.0	LF	$5.50	$1,188.00
9	2.0' x 11.0' RC Box Culvert	216.0	LF	$260.00	$56,160.00
10	Paving	50.0	SY	$10.00	$500.00
11	Seeding and Mulching	1.0	JOB	$1,000.00	$1,000.00
12	Contingency (15% Constr Cost)	1.0	JOB	LS	$13,804.00
	Total Construction				$117,031.00
	Design and Contract Administration (15% Total Constr Cost)				$17,555.00
				Total Cost	$134,586.00

APPENDIX E

Cross-Section, Discharge-Frequency, and Stage-Frequency Data

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:7-19-93_ Checked By:BES__ Date:10-20-93 Sheet 1_ of 10
Rev:LPC__ 8-24-95_ RDH__ 8-24-95_

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	Elevation NGVD WL	COMMENTS
SAWYER BROOK (INITIAL CONDITIONS)							
							SAWYER STREET
SB1C HW	0			0.257	55.6		D=3.0′ RO=62.1
		60/20	20				RCLC=62.8
SB2 {A}	60			0.257	56.3	56.4	
		457	375				
SB3 {B}	517			0.253	60.7	61.8	
		65/20	20		SPRING STREET-STATE ROUTE 5		
SB4C TW	582			0.253	61.6	61.8	D=4.0′ L=70′
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=4.0′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=2.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=3.5′ W=2.0′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW	1,908			0.128	80.5	80.5	D=2.0′ L=353′
SB14C HW	1,908			0.128	84.7	84.7	RO=90.9
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENUE
SB16C TW	2,898			0.089	88.7	89.1	D=2.0′ L=216′
SB16C HW	2,898			0.089	92.1	92.1	RO=96.1
		48/10	10				RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:11-17-94 Checked By:BES__ Date:11-17-94 Sheet 2_ of 10
Rev:LPC__ 8-24-95_ RDH__ 8-24-95_

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	Elevation NGVD WL	COMMENTS
SAWYER BROOK (PRESENT CONDITIONS)							
							SAWYER STREET
SB1C HW	0			0.257	55.6		D=3.0′ RO=62.1
		60/20	20				RCLC=62.8
SB2 {A}	60			0.257	56.3	56.4	
		457	375				
SB3 {B}	517			0.253	60.7	61.8	
		65/20	20				SPRING STREET-STATE ROUTE 5
SB4C TW	582			0.253	61.6	61.8	D=4.0′ L=70′
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=4.0′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=2.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=3.5′ W=2.0′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9
SB13T	1,675			0.133	78.4	78.5	
		233/98	95				ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 11
SB14C TW	1,908			0.128	80.9		D=3.0′ L=353′
SB14C HW	1,908			0.128	84.1		RO=90.9
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENU
SB16C TW	2,898			0.089	88.7	89.1	D=2.0′ L=216′
SB16C HW	2,898			0.089	92.1	92.1	RO=96.1
		48/10	10				RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-14-95_ Checked By:RDH__ Date:11-2-95_ Sheet 3_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 25-YR FLOOD)							
							SAWYER STREET
SB1C HW **	0			0.257	55.6		D=3.0′ RO=62.1
		60/20	20				RCLC=62.8
SB2 {A}	60			0.257	56.3	56.4	
		457	375				
SB3 {B}	517			0.253	60.7	61.8	
		65/20	20		SPRING STREET-STATE ROUTE 5		
SB4C TW	582			0.253	61.6	61.8	D=5.5′ L=70′
SB4C HW	582			0.253	62.5	62.7	RO=71.2 CMP
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=5.5′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 CMP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=4.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 CMP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=3.5′ W=3.5′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW **	1,908			0.128	80.9		D=3.0′ L=353′
SB14C HW **	1,908			0.128	84.1		RO=90.9 CMP
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENUE
SB16C TW	2,898			0.089	88.7	89.1	2-D=2.5′ L=216′
SB16C HW	2,898			0.089	92.1	92.1	CMP RO=96.1
		48/10	10		(** 1-D=2.0 RCP)		RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-15-95_ Checked By:RDH__ Date:11-2-95_ Sheet 4_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 100-YR FLOOD)							
							SAWYER STREET
SB1C HW **	0			0.257	55.6		D=3.0' RO=62.1
		60/20	20				RCLC=62.8
SB2 {A}	60			0.257	56.3	56.4	
		457	375				
SB3 {B}	517			0.253	60.7	61.8	
		65/20	20				SPRING STREET-STATE ROUTE 5
SB4C TW	582			0.253	61.6	61.8	D=6.5' L=70'
SB4C HW	582			0.253	62.5	62.7	RO=71.2 RCP
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=6.5' L=50'
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 RCP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=4.5' L=177'
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 RCP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=4.0' W=4.0'
SB12C HW	1,583			0.133	75.8	76.3	L=63' RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95				ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 11
SB14C TW	1,908			0.128	80.9		H=3.0' W=6.0'
SB14C HW	1,908			0.128	84.1		RO=90.9 L=353'
		228/10	10				RCLC=90.9 RCB
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENU
SB16C TW	2,898			0.089	88.7	89.1	H=2.0' W=8.0'
SB16C HW	2,898			0.089	92.1	92.1	RO=96.1 L=216'
		48/10	10				RCLC=96.1 RCB
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-22-95_ Checked By:RDH__ Date:11-2-95_ Sheet 5_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 25-YR FLOOD SPRING STREET OUTLET)							
					SPRING STREET-STATE ROUTE 5		
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=5.5′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 CMP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=4.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 CMP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=3.5′ W=3.5′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW **	1,908			0.128	80.9		D=3.0′ L=353′
SB14C HW **	1,908			0.128	84.1		RO=90.9 CMP
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENUE
SB16C TW	2,898			0.089	88.7	89.1	2-D=2.5′ L=216′
SB16C HW	2,898			0.089	92.1	92.1	CMP RO=96.1
		48/10	10		(** 1-D=2.0 RCP)		RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-22-95_ Checked By:RDH__ Date:11-2-95_ Sheet 6_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 100-YR FLOOD SPRING STREET OUTLET)							
					SPRING STREET-STATE ROUTE 5		
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=6.5′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 RCP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=4.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 RCP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=4.0′ W=4.0′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 11			
SB14C TW	1,908			0.128	80.9		H=3.0′ W=6.0′
SB14C HW	1,908			0.128	84.1		RO=90.9 L=353′
		228/10	10				RCLC=90.9 RCB
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENU
SB16C TW	2,898			0.089	88.7	89.1	H=2.0′ W=8.0′
SB16C HW	2,898			0.089	92.1	92.1	RO=96.1 L=216′
		48/10	10				RCLC=96.1 RCB
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-22-95_ Checked By:RDH__ Date:11-2-95_ Sheet 7_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 25-YR FLOOD SPRING STREET OUTLET - SUBAREAS G,H,& X INDUSTRIALIZED)							
					SPRING STREET-STATE ROUTE 5		
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=6.5′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 CMP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=5.0′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 CMP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=4.0′ W=4.0′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW **	1,908			0.128	80.9		D=3.0′ L=353′
SB14C HW **	1,908			0.128	84.1		RO=90.9 RCP
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		(1 PIPE ADDED)
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENUE
SB16C TW	2,898			0.089	88.7	89.1	3-D=3.0′ L=216′
SB16C HW	2,898			0.089	92.1	92.1	CMP RO=96.1
		48/10	10		(** 1-D=2.0 RCP)		RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-22-95_ Checked By:RDH__ Date:11-2-95_ Sheet 8_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 100-YR FLOOD)							
SPRING STREET OUTLET - SUBAREAS G,H,& X INDUSTRIALIZED)							
							SPRING STREET-STATE ROUTE 5
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=7.0′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 RCP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=5.0′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 RCP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW	1,583			0.133	75.5	75.5	H=4.5′ W=4.5′
SB12C HW	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 RCB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 11			
SB14C TW	1,908			0.128	80.9		H=3.0′ W=7.5′
SB14C HW	1,908			0.128	84.1		RO=90.9 L=353′
		228/10	10				RCLC=90.9 RCB
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENU
SB16C TW	2,898			0.089	88.7	89.1	H=2.0′ W=11.0
SB16C HW	2,898			0.089	92.1	92.1	RO=96.1 L=216′
		48/10	10				RCLC=96.1 RCB
SB17 {G}	2,946			0.089	92.3	92.3	LDS

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-26-95_ Checked By:RDH__ Date:11-2-95_ Sheet 9_ of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 25-YR FLOOD SPRING STREET OUTLET - SUBAREAS G,H,& X REMOVED)							
					SPRING STREET-STATE ROUTE 5		
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=4.5′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 CMP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=3.0′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 CMP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW **	1,583			0.133	75.5	75.5	H=3.5′ W=2.0′
SB12C HW **	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 CSB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW **	1,908			0.128	80.9		D=3.0′ L=353′
SB14C HW **	1,908			0.128	84.1		RO=90.9 RCP
		228/10	10				RCLC=90.9
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENUE
SB16C TW **	2,898			0.089	88.7	89.1	D=2.0′ L=216′
SB16C HW **	2,898			0.089	92.1	92.1	RCP RO=96.1
		48/10	10				RCLC=96.1
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
CROSS SECTION DATA

By:LPC___ Date:9-26-95_ Checked By:RDH__ Date:11-2-95_ Sheet 10 of 10

X-SEC. WSP2/{FPMS}	STA.	CH. DIST.	FP. DIST.	DA. SQ. MI.	Elevation NGVD CB	Elevation NGVD WL	COMMENTS
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 100-YR FLOOD)							
SPRING STREET OUTLET - SUBAREAS G,H,& X REMOVED)							
							SPRING STREET-STATE ROUTE 5
SB4C HW	582			0.253	62.5	62.7	RO=71.2
		105/80	80				RCLC=71.2
SB5 {C}	687			0.253	63.7	63.8	
		298	275				
SB6T	985			0.248	64.2	66.0	
		32/7	7				NYE STREET
SB7C TW	1,017			0.248	66.8	67.0	D=5.0′ L=50′
SB7C HW	1,017			0.248	67.2	67.4	RO=75.9 RCP
		35/10	10				RCLC=76.7
SB8 {D}	1,052			0.248	68.0	68.1	
		195	190				
SB9T	1,247			0.134	70.3	70.3	
		177/40	40				PARK STREET
SB10C TW	1,424			0.134	70.5	70.5	D=2.5′ L=177′
SB10C HW	1,424			0.134	73.9	73.9	RO=82.0 RCP
		117/77	77				RCLC=82.0
SB11 {E}	1,541			0.133	75.5	75.5	
		42/11	11				B&M R.R.
SB12C TW **	1,583			0.133	75.5	75.5	H=3.5′ W=2.0′
SB12C HW **	1,583			0.133	75.8	76.3	L=63′ RO=90.7
		92/60	60				RCLC=90.9 CSB
SB13T	1,675			0.133	78.4	78.5	
		233/98	95	ROEBUCK AVENUE/NORTH STREET-STATE ROUTE 112			
SB14C TW **	1,908			0.128	80.9		H=3.0′ W=7.5′
SB14C HW **	1,908			0.128	84.1		RO=90.9 L=353′
		228/10	10				RCLC=90.9 RCB
SB15T	2,136			0.128	84.8		
		303	297				
SB15 {F}	2,439			0.099	87.4	87.7	
		459/281	272				THERRIEN AVENU
SB16C TW **	2,898			0.089	88.7	89.1	D=2.0′
SB16C HW **	2,898			0.089	92.1	92.1	RO=96.1 L=216′
		48/10	10				RCLC=96.1 RCP
SB17 {G}	2,946			0.089	92.3	92.3	LDS

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:2-11-94_ Checked By:RH____ Date:2-11-94_ Sheet 1_ of 7_
Rev:LPC_ 6-8-94__ RH____ 6-9-94__

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (INITIAL CONDITIONS)									
SB1C	0	0.257	76	139	190	254	305	356	461
SB2 {A}	60	0.257	76	139	190	254	305	356	461
SB3 {B}	517	0.253	76	139	190	254	305	356	461
SB4C	582	0.253	76	139	190	254	305	356	461
SB5 {C}	687	0.253	76	139	190	254	305	356	461
SB6T	985	0.248	76	139	190	254	305	356	461
SB7C	1,017	0.248	76	139	190	254	305	356	461
SB8 {D}	1,052	0.248	76	139	190	254	305	356	461
SB9T	1,247	0.134	36	69	95	128	154	181	236
SB10C	1,424	0.134	36	69	95	128	154	181	236
SB11 {E}	1,541	0.133	36	69	95	128	154	181	236
SB12C	1,583	0.133	36	69	95	128	154	181	236
SB13T	1,675	0.133	36	69	95	128	154	181	236
SB14C	1,908	0.128	36	67	93	125	151	177	230
SB15T	2,136	0.128	36	67	93	125	151	177	230
SB15 {F}	2,439	0.099	28	52	72	98	118	139	181
SB16C	2,898	0.089	27	48	67	90	108	126	164
SB17 {G}	2,946	0.089	27	48	67	90	108	126	164

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:2-11-94_ Checked By:RH____ Date:2-11-94_ Sheet 2_ of 7_
Rev:LPC_ 6-8-94__ RH____ 6-9-94__

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (PRESENT CONDITIONS)									
SB1C	0	0.257	76	139	190	254	305	356	461
SB2 {A}	60	0.257	76	139	190	254	305	356	461
SB3 {B}	517	0.253	76	139	190	254	305	356	461
SB4C	582	0.253	76	139	190	254	305	356	461
SB5 {C}	687	0.253	76	139	190	254	305	356	461
SB6T	985	0.248	76	139	190	254	305	356	461
SB7C	1,017	0.248	76	139	190	254	305	356	461
SB8 {D}	1,052	0.248	76	139	190	254	305	356	461
SB9T	1,247	0.134	36	69	95	128	154	181	236
SB10C	1,424	0.134	36	69	95	128	154	181	236
SB11 {E}	1,541	0.133	36	69	95	128	154	181	236
SB12C	1,583	0.133	36	69	95	128	154	181	236
SB13T	1,675	0.133	36	69	95	128	154	181	236
SB14C	1,908	0.128	36	67	93	125	151	177	230
SB15T	2,136	0.128	36	67	93	125	151	177	230
SB15 {F}	2,439	0.099	28	52	72	98	118	139	181
SB16C	2,898	0.089	27	48	67	90	108	126	164
SB17 {G}	2,946	0.089	27	48	67	90	108	126	164

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:2-11-94_ Checked By:BES___ Date:2-22-94_ Sheet 3_ of 7_
Rev:LPC_ 6-8-94__ RH____ 6-9-94__

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS SUBAREAS G,H,&X REMOVED)									
SB1C	0	0.168	54	95	128	170	203	236	304
SB2 {A}	60	0.168	54	95	128	170	203	236	304
SB3 {B}	517	0.164	54	95	128	170	203	236	304
SB4C	582	0.164	54	95	128	170	203	236	304
SB5 {C}	687	0.164	54	95	128	170	203	236	304
SB6T	985	0.159	52	91	123	164	196	229	294
SB7C	1,017	0.159	52	91	123	164	196	229	294
SB8 {D}	1,052	0.159	52	91	123	164	196	229	294
SB9T	1,247	0.045	13	24	32	43	51	60	78
SB10C	1,424	0.045	13	24	32	43	51	60	78
SB11 {E}	1,541	0.044	13	24	32	43	51	60	78
SB12C	1,583	0.044	13	24	32	43	51	60	78
SB13T	1,675	0.044	13	24	32	43	51	60	78
SB14C	1,908	0.039	11	21	28	38	45	53	69
SB15T	2,136	0.039	11	21	28	38	45	53	69
SB15 {F}	2,439	0.010	3	6	8	11	13	16	21
SB16C	2,898	0.000	0	0	0	0	0	0	0
SB17 {G}	2,946	0.000	0	0	0	0	0	0	0

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:3-1-94__ Checked By:RH____ Date:3-14-94_ Sheet 4_ of 7_
Rev:LPC_ 6-13-94_ RH____ 6-14-94_

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET)									
SS1T		0.390	113	199	269	360	432	505	654
SOUTH STREET		0.336	106	185	250	334	399	465	601
SB4C	582	0.253	76	139	190	254	305	356	461
SB5 {C}	687	0.253	76	139	190	254	305	356	461
SB6T	985	0.248	76	139	190	254	305	356	461
SB7C	1,017	0.248	76	139	190	254	305	356	461
SB8 {D}	1,052	0.248	76	139	190	254	305	356	461
SB9T	1,247	0.134	36	69	95	128	154	181	236
SB10C	1,424	0.134	36	69	95	128	154	181	236
SB11 {E}	1,541	0.133	36	69	95	128	154	181	236
SB12C	1,583	0.133	36	69	95	128	154	181	236
SB13T	1,675	0.133	36	69	95	128	154	181	236
SB14C	1,908	0.128	36	67	93	125	151	177	230
SB15T	2,136	0.128	36	67	93	125	151	177	230
SB15 {F}	2,439	0.099	28	52	72	98	118	139	181
SB16C	2,898	0.089	27	48	67	90	108	126	164
SB17 {G}	2,946	0.089	27	48	67	90	108	126	164

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:3-1-94__ Checked By:RH____ Date:3-14-94_ Sheet 5_ of 7_
Rev:LPC_ 6-13-94_ RH____ 6-14-94_

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING ST. OUTLET SUBAREAS G,H,&X REMOVED)									
SS1T		0.301	97	161	215	285	342	398	512
SOUTH STREET		0.247	88	143	191	253	302	351	450
SB4C	582	0.164	54	95	128	170	203	236	304
SB5 {C}	687	0.164	54	95	128	170	203	236	304
SB6T	985	0.159	52	91	123	164	196	229	294
SB7C	1,017	0.159	52	91	123	164	196	229	294
SB8 {D}	1,052	0.159	52	91	123	164	196	229	294
SB9T	1,247	0.045	13	24	32	43	51	60	78
SB10C	1,424	0.045	13	24	32	43	51	60	78
SB11 {E}	1,541	0.044	13	24	32	43	51	60	78
SB12C	1,583	0.044	13	24	32	43	51	60	78
SB13T	1,675	0.044	13	24	32	43	51	60	78
SB14C	1,908	0.039	11	21	28	38	45	53	69
SB15T	2,136	0.039	11	21	28	38	45	53	69
SB15 {F}	2,439	0.010	3	6	8	11	13	16	21
SB16C	2,898	0.000	0	0	0	0	0	0	0
SB17 {G}	2,946	0.000	0	0	0	0	0	0	0

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:11-17-94 Checked By:BES___ Date:8-17-95_ Sheet 6_ of 7_

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS SUBAREAS G,H,&X INDUSTRIALIZED)									
SB1C	0	0.257	122	191	242	309	365	417	523
SB2 {A}	60	0.257	122	191	242	309	365	417	523
SB3 {B}	517	0.253	122	191	242	309	365	417	523
SB4C	582	0.253	122	191	242	309	365	417	523
SB5 {C}	687	0.253	122	191	242	309	365	417	523
SB6T	985	0.248	122	191	242	309	365	417	523
SB7C	1,017	0.248	122	191	242	309	365	417	523
SB8 {D}	1,052	0.248	122	191	242	309	365	417	523
SB9T	1,247	0.134	81	120	146	182	213	241	297
SB10C	1,424	0.134	81	120	146	182	213	241	297
SB11 {E}	1,541	0.133	81	120	146	182	213	241	297
SB12C	1,583	0.133	81	120	146	182	213	241	297
SB13T	1,675	0.133	81	120	146	182	213	241	297
SB14C	1,908	0.128	82	120	147	182	212	239	297
SB15T	2,136	0.128	82	120	147	182	212	239	297
SB15 {F}	2,439	0.099	72	103	123	151	176	197	240
SB16C	2,898	0.089	70	98	117	142	164	183	221
SB17 {G}	2,946	0.089	70	98	117	142	164	183	221

PROJECT: SACO, MAINE FPMS
DISCHARGE-FREQUENCY DATA

By:LPC__ Date:8-14-95_ Checked By:BES___ Date:8-17-95_ Sheet 7_ of 7_

X-SEC. WSP2/{FPMS}	STA.	D.A. MI.2	Discharge-CFS 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING ST. OUTLET SUBAREAS G,H,&X INDUSTRIALIZED)									
SS1T		0.390	162	251	322	416	494	568	718
SOUTH STREET		0.336	155	237	303	390	461	528	665
SB4C	582	0.253	122	191	242	309	365	417	523
SB5 {C}	687	0.253	122	191	242	309	365	417	523
SB6T	985	0.248	122	191	242	309	365	417	523
SB7C	1,017	0.248	122	191	242	309	365	417	523
SB8 {D}	1,052	0.248	122	191	242	309	365	417	523
SB9T	1,247	0.134	81	120	146	182	213	241	297
SB10C	1,424	0.134	81	120	146	182	213	241	297
SB11 {E}	1,541	0.133	81	120	146	182	213	241	297
SB12C	1,583	0.133	81	120	146	182	213	241	297
SB13T	1,675	0.133	81	120	146	182	213	241	297
SB14C	1,908	0.128	82	120	147	182	212	239	293
SB15T	2,136	0.128	82	120	147	182	212	239	293
SB15 {F}	2,439	0.099	72	103	123	151	176	197	240
SB16C	2,898	0.089	70	98	117	142	164	183	221
SB17 {G}	2,946	0.089	70	98	117	142	164	183	221

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:2-14-94_ Checked By:BES___ Date:2-22-94_ Sheet 1_ of 15
Rev:LPC_ 11-6-95_ RDH___ 11-6-95

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (INITIAL CONDITIONS)									
SB1C HW	0	55.6	62.5	62.6	62.7	62.7	62.8	62.8	62.9
SB2 {A}	60	56.3	62.6	62.8	62.9	63.0	63.1	63.1	63.3
SB3 {B}	517	60.7	64.5	65.4	65.7	66.3	66.5	66.8	67.2
SB4C TW	582	61.6	64.7	65.5	65.9	66.4	66.6	66.9	67.3
SB4C HW	582	62.5	66.6	70.6	71.9	72.2	72.4	72.6	72.9
SB5 {C}	687	63.7	66.8	70.6	71.9	72.3	72.4	72.6	72.9
SB6T	985	64.2	67.5	70.8	72.0	72.4	72.6	72.8	73.2
SB7C TW	1,017	66.8	68.4	70.8	72.0	72.4	72.6	72.8	73.2
SB7C HW	1,017	67.2	71.7	75.2	76.5	76.7	76.9	77.0	77.2
SB8 {D}	1,052	68.0	71.7	75.2	76.5	76.7	76.9	77.0	77.2
SB9T	1,247	70.3	72.4	75.2	76.5	76.8	77.0	77.1	77.4
SB10C TW	1,424	70.5	72.6	75.3	76.5	76.8	77.0	77.2	77.5
SB10C HW	1,424	73.9	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB11 {E}	1,541	75.5	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB12C TW	1,583	75.5	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB12C HW	1,583	75.8	81.1	87.0	87.4	87.6	87.8	87.9	88.1
SB13T	1,675	78.4	81.1	87.0	87.4	87.6	87.8	87.9	88.1
SB14C TW	1,908	80.5	82.0	87.0	87.4	87.6	87.8	87.9	88.1
SB14C HW	1,908	84.7	91.4	91.7	91.8	92.0	92.1	92.1	92.3
SB15T	2,136	84.8	91.4	91.7	91.8	92.0	92.1	92.1	92.3
SB15 {F}	2,439	87.4	91.4	91.7	91.9	92.1	92.2	92.3	92.5
SB16C TW	2,898	88.7	91.5	91.9	92.1	92.3	92.5	92.6	92.9
SB16C HW	2,898	92.1	95.7	96.5	96.6	96.6	96.7	96.8	96.9
SB17 {G}	2,946	92.3	95.7	96.5	96.6	96.6	96.7	96.8	96.9

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:2-16-94_ Checked By:BES___ Date:2-22-94_ Sheet 2_ of 15
Rev:LPC_ 11-6-95_ RDH___ 11-6-95_

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (PRESENT CONDITIONS - TWO 3' D CULVERTS AT SB14C)									
SB1C HW	0	55.6	62.5	62.6	62.7	62.7	62.8	62.8	62.9
SB2 {A}	60	56.3	62.6	62.8	62.9	63.0	63.1	63.1	63.3
SB3 {B}	517	60.7	64.5	65.4	65.7	66.3	66.5	66.8	67.2
SB4C TW	582	61.6	64.7	65.5	65.9	66.4	66.6	66.9	67.3
SB4C HW	582	62.5	66.6	70.6	71.9	72.2	72.4	72.6	72.9
SB5 {C}	687	63.7	66.8	70.6	71.9	72.3	72.4	72.6	72.9
SB6T	985	64.2	67.5	70.8	72.0	72.4	72.6	72.8	73.2
SB7C TW	1,017	66.8	68.4	70.7	72.0	72.4	72.6	72.8	73.2
SB7C HW	1,017	67.2	71.7	75.2	76.5	76.7	76.9	77.0	77.2
SB8 {D}	1,052	68.0	71.7	75.2	76.5	76.7	76.9	77.0	77.2
SB9T	1,247	70.3	72.4	75.2	76.5	76.8	77.0	77.1	77.4
SB10C TW	1,424	70.5	72.6	75.3	76.5	76.8	77.0	77.2	77.5
SB10C HW	1,424	73.9	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB11 {E}	1,541	75.5	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB12C TW	1,583	75.5	79.7	82.7	82.9	83.1	83.2	83.3	83.5
SB12C HW	1,583	75.8	81.1	87.0	87.4	87.6	87.8	87.9	88.1
SB13T	1,675	78.4	81.1	87.0	87.4	87.6	87.8	87.9	88.1
SB14C TW	1,908	80.9	82.4	87.0	87.4	87.6	87.8	87.9	88.1
SB14C HW	1,908	84.1	86.2	88.3	89.7	91.3	91.5	91.7	91.9
SB15T	2,136	84.8	86.2	88.3	89.7	91.3	91.5	91.7	91.9
SB15 {F}	2,439	87.4	88.7	89.5	90.2	91.4	91.7	91.9	92.2
SB16C TW	2,898	88.7	90.3	90.8	91.1	91.9	92.1	92.3	92.7
SB16C HW	2,898	92.1	95.7	96.4	96.5	96.6	96.7	96.7	96.9
SB17 {G}	2,946	92.3	95.7	96.4	96.5	96.6	96.7	96.7	96.9

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:2-16-94_ Checked By:BES___ Date:2-22-94_ Sheet 3_ of 1
Rev:LPC_ 8-24-95_ RDH___ 8-24-95_

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SUBAREAS G,H,X REMOVED, TWO 3' D CULVERTS AT SB14C)									
SB1C HW	0	55.6	62.4	62.5	62.6	62.6	62.7	62.7	62.8
SB2 {A}	60	56.3	62.5	62.7	62.7	62.8	62.9	62.9	63.1
SB3 {B}	517	60.7	64.2	64.8	65.2	65.7	65.9	66.2	66.5
SB4C TW	582	61.6	64.4	65.0	65.3	65.8	66.0	66.3	66.6
SB4C HW	582	62.5	65.7	67.7	69.7	71.7	72.0	72.2	72.4
SB5 {C}	687	63.7	66.0	67.8	69.7	71.7	72.0	72.2	72.4
SB6T	985	64.2	66.9	68.3	69.9	71.8	72.1	72.3	72.6
SB7C TW	1,017	66.8	68.1	68.5	69.9	71.8	72.1	72.3	72.5
SB7C HW	1,017	67.2	70.8	72.4	74.1	76.3	76.5	76.7	76.9
SB8 {D}	1,052	68.0	70.8	72.4	74.1	76.3	76.5	76.7	76.9
SB9T	1,247	70.3	71.5	72.7	74.2	76.3	76.5	76.7	76.9
SB10C TW	1,424	70.5	71.7	72.7	74.2	76.4	76.5	76.7	76.9
SB10C HW	1,424	73.9	75.7	76.5	79.2	82.4	82.5	82.6	82.8
SB11 {E}	1,541	75.5	76.4	76.9	79.2	82.4	82.5	82.6	82.8
SB12C TW	1,583	75.5	76.5	77.0	79.2	82.4	82.5	82.6	82.8
SB12C HW	1,583	75.8	77.8	78.8	80.2	84.1	84.9	85.8	87.1
SB13T	1,675	78.4	79.1	79.6	80.3	84.1	84.9	85.8	87.1
SB14C TW	1,908	80.9	81.7	82.0	82.2	84.1	84.9	85.8	87.1
SB14C HW	1,908	84.1	85.0	85.5	85.9	86.2	86.4	86.6	88.4
SB15T	2,136	84.8	85.5	85.7	86.0	86.3	86.4	86.6	88.4
SB15 {F}	2,439	87.4	88.0	88.2	88.2	88.2	88.3	88.4	89.0
SB16C TW	2,898	88.7	89.4	89.5	89.6	89.7	89.7	89.9	90.0
SB16C HW	2,898	92.1	92.2	92.2	92.2	92.2	92.2	92.2	92.2
SB17 {G}	2,946	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:3-14-94_ Checked By:RH____ Date:3-14-94_ Sheet 4_ of 15
Rev:LPC_ 11-6-95_ RDH___ 11-6-95_

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - TWO 3' D CULVERTS AT SB14C - SPRING STREET OUTLET)									
SB4C HW	582	62.5				66.5		69.1	
SB5 {C}	687	63.7				66.5		69.1	
SB6T	985	64.2				69.4		70.4	
SB7C TW	1,017	66.8				69.7		70.4	
SB7C HW	1,017	67.2				76.7		77.0	
SB8 {D}	1,052	68.0				76.7		77.0	
SB9T	1,247	70.3				76.8		77.1	
SB10C TW	1,424	70.5				76.8		77.1	
SB10C HW	1,424	73.9				83.1		83.3	
SB11 {E}	1,541	75.5				83.1		83.3	
SB12C TW	1,583	75.5				83.1		83.3	
SB12C HW	1,583	75.8				87.6		87.9	
SB13T	1,675	78.4				87.6		87.9	
SB14C TW	1,908	80.9				87.6		87.9	
SB14C HW	1,908	84.1				91.3		91.7	
SB15T	2,136	84.8				91.3		91.7	
SB15 {F}	2,439	87.4				91.4		91.9	
SB16C TW	2,898	88.7				91.9		92.3	
SB16C HW	2,898	92.1				96.6		96.8	
SB17 {G}	2,946	92.3				96.6		96.8	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:11-17-94 Checked By:BES___ Date:8-18-95_ Sheet 5_ of 1
Rev:LPC_ 8-24-95_ RDH___ 8-24-95_

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SUBAREAS G,H,X INDUSTRIALIZED, TWO 3' D CULVERTS AT SB14C)									
SB1C HW	0	55.6	62.6	62.7	62.7	62.8	62.9	62.9	63.0
SB2 {A}	60	56.3	62.7	62.9	63.0	63.1	63.1	63.2	63.3
SB3 {B}	517	60.7	65.2	65.8	66.1	66.5	66.9	67.1	67.5
SB4C TW	582	61.6	65.3	65.9	66.2	66.6	66.9	67.2	67.6
SB4C HW	582	62.5	69.3	71.9	72.2	72.4	72.6	72.8	73.0
SB5 {C}	687	63.7	69.3	71.9	72.2	72.5	72.6	72.8	73.0
SB6T	985	64.2	69.6	72.0	72.3	72.6	72.9	73.0	73.3
SB7C TW	1,017	66.8	69.6	72.0	72.3	72.6	72.9	73.0	73.3
SB7C HW	1,017	67.2	73.9	76.5	76.7	76.9	77.0	77.2	77.4
SB8 {D}	1,052	68.0	73.9	76.5	76.7	76.9	77.0	77.2	77.4
SB9T	1,247	70.3	74.2	76.6	76.8	77.0	77.2	77.4	77.6
SB10C TW	1,424	70.5	74.2	76.6	76.8	77.1	77.3	77.4	77.7
SB10C HW	1,424	73.9	82.7	83.0	83.1	83.3	83.4	83.5	83.7
SB11 {E}	1,541	75.5	82.7	83.0	83.1	83.3	83.4	83.5	83.7
SB12C TW	1,583	75.5	82.7	83.0	83.2	83.3	83.4	83.5	83.7
SB12C HW	1,583	75.8	86.9	87.5	87.7	87.9	88.0	88.1	88.3
SB13T	1,675	78.4	86.9	87.5	87.7	87.9	88.0	88.1	88.3
SB14C TW	1,908	80.9	86.9	87.5	87.7	87.9	88.0	88.1	88.3
SB14C HW	1,908	84.1	88.2	90.7	91.4	91.7	91.9	92.0	92.2
SB15T	2,136	84.8	88.2	90.7	91.4	91.7	91.9	92.0	92.2
SB15 {F}	2,439	87.4	89.4	91.0	91.6	91.9	92.1	92.3	92.5
SB16C TW	2,898	88.7	90.8	91.6	92.1	92.4	92.6	92.8	93.1
SB16C HW	2,898	92.1	96.5	96.6	96.7	96.8	96.8	96.9	97.0
SB17 {G}	2,946	92.3	96.5	96.6	96.7	96.8	96.8	96.9	97.0

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:11-6-95_ Checked By:RDH___ Date:11-6-95_ Sheet 6_ of 15

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 25-YEAR FLOOD)									
SB1C HW **	0	55.6	62.5	62.6	62.7	62.7	62.8	62.8	62.9
SB2 {A}	60	56.3	62.6	62.8	62.9	63.0	63.1	63.1	63.3
SB3 {B}	517	60.7	64.5	65.4	65.7	66.3	66.5	66.8	67.2
SB4C TW	582	61.6	64.7	65.5	65.9	66.4	66.6	66.9	67.3
SB4C HW	582	62.5	65.8	67.4	69.2	70.9	71.8	72.1	72.5
SB5 {C}	687	63.7	66.3	67.7	69.3	70.9	71.8	72.1	72.5
SB6T	985	64.2	67.3	68.6	69.9	71.3	72.1	72.4	72.9
SB7C TW	1,017	66.8	68.4	69.0	69.9	71.3	72.1	72.4	72.9
SB7C HW	1,017	67.2	71.0	72.6	73.9	75.5	76.3	76.6	76.9
SB8 {D}	1,052	68.0	71.0	72.6	73.9	75.5	76.3	76.6	76.9
SB9T	1,247	70.3	72.2	73.3	74.3	75.7	76.5	76.8	77.2
SB10C TW	1,424	70.5	72.5	73.5	74.4	75.7	76.5	76.8	77.2
SB10C HW	1,424	73.9	76.4	77.5	78.3	79.9	82.3	82.7	83.1
SB11 {E}	1,541	75.5	77.0	77.9	78.6	80.0	82.3	82.7	83.1
SB12C TW	1,583	75.5	77.2	78.0	78.6	80.0	82.3	82.7	83.1
SB12C HW	1,583	75.8	78.4	79.8	81.1	83.1	86.8	87.3	87.7
SB13T	1,675	78.4	79.6	80.5	81.3	83.1	86.8	87.3	87.7
SB14C TW **	1,908	80.9	82.2	82.7	83.1	83.9	86.8	87.4	87.7
SB14C HW **	1,908	84.1	86.2	87.0	87.6	88.4	91.4	91.7	91.9
SB15T	2,136	84.8	86.2	87.0	87.6	88.4	91.4	91.7	91.9
SB15 {F}	2,439	87.4	88.7	89.3	89.5	90.0	91.6	91.9	92.2
SB16C TW	2,898	88.7	90.3	90.7	91.0	91.3	92.1	92.3	92.7
SB16C HW	2,898	92.1	93.6	94.3	94.9	95.9	96.4	96.6	96.7
SB17 {G}	2,946	92.3	93.7	94.3	94.9	95.9	96.4	96.6	96.7

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-15-95_ Checked By:RDH___ Date:11-3-95_ Sheet 7_ of 1

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - CULVERTS REPLACED TO PASS 100-YEAR FLOOD)									
SB1C HW **	0	55.6	62.5	62.6	62.7	62.7	62.8	62.8	62.9
SB2 {A}	60	56.3	62.6	62.8	62.9	63.0	63.1	63.1	63.3
SB3 {B}	517	60.7	64.5	65.4	65.7	66.3	66.5	66.8	67.2
SB4C TW	582	61.6	64.7	65.5	65.9	66.4	66.6	66.9	67.3
SB4C HW	582	62.5	65.5	66.9	67.7	68.7	69.6	70.6	71.9
SB5 {C}	687	63.7	66.1	67.3	68.1	69.0	69.8	70.7	72.0
SB6T	985	64.2	67.3	68.4	69.1	69.9	70.6	71.4	72.5
SB7C TW	1,017	66.8	68.4	69.0	69.3	69.9	70.6	71.4	72.5
SB7C HW	1,017	67.2	70.3	71.6	72.5	73.4	74.3	75.3	76.5
SB8 {D}	1,052	68.0	70.3	71.6	72.5	73.4	74.3	75.3	76.5
SB9T	1,247	70.3	72.1	72.9	73.6	74.2	74.9	75.7	76.8
SB10C TW	1,424	70.5	72.4	73.2	73.8	74.4	75.1	75.8	76.8
SB10C HW	1,424	73.9	76.3	77.4	78.1	79.0	79.9	81.0	82.6
SB11 {E}	1,541	75.5	77.1	77.9	78.5	79.2	80.0	81.0	82.6
SB12C TW	1,583	75.5	77.2	77.9	78.5	79.2	80.0	81.0	82.6
SB12C HW	1,583	75.8	78.2	79.4	80.3	81.6	82.7	84.5	87.4
SB13T	1,675	78.4	79.7	80.2	80.8	81.8	82.8	84.5	87.4
SB14C TW	1,908	80.9	82.2	82.7	83.0	83.3	83.9	84.9	87.4
SB14C HW	1,908	84.1	85.8	86.6	87.2	88.1	88.8	89.8	91.7
SB15T	2,136	84.8	85.9	86.6	87.2	88.1	88.8	89.8	91.7
SB15 {F}	2,439	87.4	88.8	89.2	89.4	89.8	90.1	90.7	92.0
SB16C TW	2,898	88.7	90.2	90.6	90.8	91.2	91.4	91.7	92.6
SB16C HW	2,898	92.1	93.2	93.7	94.1	94.7	95.2	95.8	96.4
SB17 {G}	2,946	92.3	93.5	93.9	94.2	94.7	95.2	95.8	96.4

NOTE: ** MEANS CULVERT NOT REPLACED

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:11-6-95_ Checked By:RDH___ Date:11-6-95_ Sheet 8_ of 15

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 25-YEAR FLOOD)									
SB4C HW	582	62.5				66.5		69.1	
SB5 {C}	687	63.7				66.5		69.1	
SB6T	985	64.2				69.4		70.4	
SB7C TW	1,017	66.8				69.7		70.4	
SB7C HW	1,017	67.2				75.5		76.6	
SB8 {D}	1,052	68.0				75.5		76.6	
SB9T	1,247	70.3				75.7		76.7	
SB10C TW	1,424	70.5				75.7		76.8	
SB10C HW	1,424	73.9				79.9		82.7	
SB11 {E}	1,541	75.5				79.9		82.7	
SB12C TW	1,583	75.5				79.9		82.7	
SB12C HW	1,583	75.8				83.0		87.3	
SB13T	1,675	78.4				83.1		87.3	
SB14C TW	1,908	80.9				83.8		87.3	
SB14C HW	1,908	84.1				88.4		91.7	
SB15T	2,136	84.8				88.4		91.7	
SB15 {F}	2,439	87.4				89.9		91.9	
SB16C TW	2,898	88.7				91.3		92.3	
SB16C HW	2,898	92.1				95.9		96.5	
SB17 {G}	2,946	92.3				95.9		96.5	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-25-95_ Checked By:RDH___ Date:11-3-95_ Sheet 9_ of 1

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 100-YEAR FLOOD)									
SB4C HW	582	62.5				66.5		69.1	
SB5 {C}	687	63.7				66.5		69.1	
SB6T	985	64.2				69.4		70.4	
SB7C TW	1,017	66.8				69.7		70.4	
SB7C HW	1,017	67.2				73.4		75.3	
SB8 {D}	1,052	68.0				73.4		75.3	
SB9T	1,247	70.3				74.2		75.7	
SB10C TW	1,424	70.5				74.4		75.8	
SB10C HW	1,424	73.9				79.0		81.0	
SB11 {E}	1,541	75.5				79.2		81.0	
SB12C TW	1,583	75.5				79.2		81.0	
SB12C HW	1,583	75.8				81.6		84.6	
SB13T	1,675	78.4				81.8		84.6	
SB14C TW	1,908	80.9				83.3		84.9	
SB14C HW	1,908	84.1				88.1		89.8	
SB15T	2,136	84.8				88.1		89.8	
SB15 {F}	2,439	87.4				89.8		90.7	
SB16C TW	2,898	88.7				91.2		91.8	
SB16C HW	2,898	92.1				94.7		95.8	
SB17 {G}	2,946	92.3				94.7		95.8	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-25-95_ Checked By:RDH___ Date:11-3-95_ Sheet 10 of 15

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 25-YEAR FLOOD - SUBAREAS G,H,& X INDUSTRIALIZED)									
SB4C HW	582	62.5				66.8		71.1	
SB5 {C}	687	63.7				66.8		71.1	
SB6T	985	64.2				69.8		71.8	
SB7C TW	1,017	66.8				70.0		71.8	
SB7C HW	1,017	67.2				75.5		76.5	
SB8 {D}	1,052	68.0				75.5		76.5	
SB9T	1,247	70.3				75.8		76.8	
SB10C TW	1,424	70.5				75.9		76.9	
SB10C HW	1,424	73.9				80.9		82.8	
SB11 {E}	1,541	75.5				80.9		82.8	
SB12C TW	1,583	75.5				80.9		82.9	
SB12C HW	1,583	75.8				84.5		87.5	
SB13T	1,675	78.4				84.5		87.5	
SB14C TW	1,908	80.9				84.8		87.5	
SB14C HW	1,908	84.1				88.7		91.7	
SB15T	2,136	84.8				88.7		91.7	
SB15 {F}	2,439	87.4				90.3		92.1	
SB16C TW	2,898	88.7				91.7		92.7	
SB16C HW	2,898	92.1				95.7		96.5	
SB17 {G}	2,946	92.3				95.7		96.5	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-25-95_ Checked By:RDH___ Date:11-3-95_ Sheet 11 of 1

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 100-YEAR FLOOD - SUBAREAS G,H,& X INDUSTRIALIZED)									
SB4C HW	582	62.5				66.8		71.1	
SB5 {C}	687	63.7				66.8		71.1	
SB6T	985	64.2				69.8		71.8	
SB7C TW	1,017	66.8				70.0		71.8	
SB7C HW	1,017	67.2				74.0		75.7	
SB8 {D}	1,052	68.0				74.0		75.7	
SB9T	1,247	70.3				74.8		76.2	
SB10C TW	1,424	70.5				75.0		76.3	
SB10C HW	1,424	73.9				79.9		81.9	
SB11 {E}	1,541	75.5				80.0		82.0	
SB12C TW	1,583	75.5				80.1		82.0	
SB12C HW	1,583	75.8				82.4		85.8	
SB13T	1,675	78.4				82.6		85.8	
SB14C TW	1,908	80.9				83.9		85.9	
SB14C HW	1,908	84.1				88.5		90.8	
SB15T	2,136	84.8				88.5		90.8	
SB15 {F}	2,439	87.4				90.2		91.4	
SB16C TW	2,898	88.7				91.7		92.4	
SB16C HW	2,898	92.1				94.9		96.1	
SB17 {G}	2,946	92.3				94.9		96.1	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-25-95_ Checked By:RDH___ Date:11-3-95_ Sheet 12 of 15

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - SUBAREAS G,H,& X INDUSTRIALIZED)									
SB4C HW	582	62.5				66.8		71.1	
SB5 {C}	687	63.7				66.8		71.1	
SB6T	985	64.2				69.8		71.8	
SB7C TW	1,017	66.8				70.0		71.8	
SB7C HW	1,017	67.2				76.8		77.1	
SB8 {D}	1,052	68.0				76.8		77.1	
SB9T	1,247	70.3				77.0		77.3	
SB10C TW	1,424	70.5				77.0		77.4	
SB10C HW	1,424	73.9				83.3		83.5	
SB11 {E}	1,541	75.5				83.3		83.5	
SB12C TW	1,583	75.5				83.3		83.5	
SB12C HW	1,583	75.8				87.9		88.1	
SB13T	1,675	78.4				87.9		88.1	
SB14C TW	1,908	80.9				87.9		88.1	
SB14C HW	1,908	84.1				91.7		92.0	
SB15T	2,136	84.8				91.7		92.0	
SB15 {F}	2,439	87.4				91.9		92.3	
SB16C TW	2,898	88.7				92.4		92.8	
SB16C HW	2,898	92.1				96.8		96.9	
SB17 {G}	2,946	92.3				96.8		96.9	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-28-95_ Checked By:RDH___ Date:11-3-95_ Sheet 13 of 1

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - SUBAREAS G,H,& X REMOVED)									
SB4C HW	582	62.5				66.0		70.2	
SB5 {C}	687	63.7				66.0		70.2	
SB6T	985	64.2				68.4		70.7	
SB7C TW	1,017	66.8				69.2		70.7	
SB7C HW	1,017	67.2				76.2		76.6	
SB8 {D}	1,052	68.0				76.2		76.6	
SB9T	1,247	70.3				76.2		76.6	
SB10C TW	1,424	70.5				76.2		76.6	
SB10C HW	1,424	73.9				82.4		82.6	
SB11 {E}	1,541	75.5				82.4		82.6	
SB12C TW	1,583	75.5				82.4		82.6	
SB12C HW	1,583	75.8				84.1		85.8	
SB13T	1,675	78.4				84.1		85.8	
SB14C TW	1,908	80.9				84.1		85.8	
SB14C HW	1,908	84.1				86.2		86.6	
SB15T	2,136	84.8				86.3		86.6	
SB15 {F}	2,439	87.4				88.2		88.4	
SB16C TW	2,898	88.7				89.7		89.9	
SB16C HW	2,898	92.1				92.2		92.2	
SB17 {G}	2,946	92.3				92.3		92.3	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-28-95_ Checked By:RDH___ Date:11-3-95_ Sheet 14 of 15

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 25-YEAR FLOOD - SUBAREAS G,H,& X REMOVED)									
SB4C HW	582	62.5				66.0		70.2	
SB5 {C}	687	63.7				66.0		70.2	
SB6T	985	64.2				68.4		70.6	
SB7C TW	1,017	66.8				69.1		70.6	
SB7C HW	1,017	67.2				74.6		76.4	
SB8 {D}	1,052	68.0				74.6		76.4	
SB9T	1,247	70.3				74.7		76.4	
SB10C TW	1,424	70.5				74.7		76.4	
SB10C HW	1,424	73.9				78.1		82.3	
SB11 {E}	1,541	75.5				78.2		82.3	
SB12C TW	1,583	75.5				78.2		82.3	
SB12C HW	1,583	75.8				80.1		85.4	
SB13T	1,675	78.4				80.4		85.4	
SB14C TW	1,908	80.9				82.4		85.4	
SB14C HW	1,908	84.1				86.2		86.6	
SB15T	2,136	84.8				86.3		86.6	
SB15 {F}	2,439	87.4				88.4		88.6	
SB16C TW	2,898	88.7				89.7		89.9	
SB16C HW	2,898	92.1				92.2		92.2	
SB17 {G}	2,946	92.3				92.3		92.3	

PROJECT: SACO, MAINE FPMS
STAGE-FREQUENCY DATA

By:LPC__ Date:9-28-95_ Checked By:RDH___ Date:11-3-95_ Sheet 15 of 1

X-SEC. WSP2/{FPMS}	STA.	C.B.	Elevation NGVD 2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
SAWYER BROOK (FUTURE CONDITIONS - SPRING STREET OUTLET - CULVERTS REPLACED TO PASS 100-YEAR FLOOD - SUBAREAS G,H,& X REMOVED)									
SB4C HW	582	62.5				66.0		70.2	
SB5 {C}	687	63.7				66.0		70.2	
SB6T	985	64.2				68.4		70.7	
SB7C TW	1,017	66.8				69.2		70.7	
SB7C HW	1,017	67.2				72.9		74.8	
SB8 {D}	1,052	68.0				72.9		74.8	
SB9T	1,247	70.3				73.2		75.0	
SB10C TW	1,424	70.5				73.3		75.0	
SB10C HW	1,424	73.9				78.0		81.0	
SB11 {E}	1,541	75.5				78.1		81.0	
SB12C TW	1,583	75.5				78.1		81.0	
SB12C HW	1,583	75.8				80.2		84.3	
SB13T	1,675	78.4				80.4		84.3	
SB14C TW	1,908	80.9				82.4		84.4	
SB14C HW	1,908	84.1				86.2		86.6	
SB15T	2,136	84.8				86.3		86.6	
SB15 {F}	2,439	87.4				88.2		88.5	
SB16C TW	2,898	88.7				89.7		89.9	
SB16C HW	2,898	92.1				92.2		92.2	
SB17 {G}	2,946	92.3				92.3		92.3	

APPENDIX F

Water Quality Analysis

YORK COUNTY SOIL AND WATER CONSERVATION DISTRICT
160 COTTAGE STREET - SANFORD, MAINE 04073
(207)324-7015

Mr. William G. Hoffman, P.E. March 10, 1995
DeLUCA HOFFMAN ASSOCIATES, INC.
778 Main Street
Suite 8
South Portland, Maine 04106

Re: Sawyer Brook Watershed Study
Water Quality Analysis

Dear Bill:

I have completed a water quality analysis for the referenced project. This study was conducted for both the existing and improved conditions using the Simple Method analysis.

Please review the enclosed study and results and let me know your comments.

Sincerely;

Kenneth A. Wood

Kenneth A. Wood, P.E.
District Engineer

YORK COUNTY SOIL AND WATER CONSERVATION DISTRICT
160 COTTAGE STREET - SANFORD, MAINE 04073
(207)324-7015

WATER QUALITY ANALYSIS
SAWYER BROOK WATERSHED

MARCH 2, 1995

This water quality analysis was conducted on the Sawyer Brook Watershed, located in Saco, Maine. This watershed contains approximately 354 acres of urban developed, and commercial land uses. The current existing condition contains combined (CS0) catchments in some of the drainage areas. Additionally, remnants of the original Sawyer Brook, and associated conduits, are present. The proposed condition will contain separated stormwater from wastewater systems, and improved culverted sections, to resolve frequent flooding. Additionally, an additional subcatchment, Sub Area Y, will be routed to the watershed in the proposed condition.

This water quality analysis utilizes the Simple Method to predict pollutant loadings in the existing and proposed conditions. The Simple Method incorporates the equation **L = [(P) (Pj) (Rv)/12] (C) (A) (2.72)** to predict pollutant export. Variables are defined as follows:

L = storm pollutant export in pounds.
P = rainfall depth in inches over a specific time interval.
Pj = correction factor for storms that produce no runoff.
Rv = runoff coefficient based on impervious area.
C = flow weighted mean concentration of the pollutant in mg/l.
A = area in acres
12 and 2.72 = unit conversion factors.

In this analysis the following values were used:

P = 1" rainfall to represent the "first flush". An annual P = 46.7" was used in some cases for an annual loading comparison.
Pj = 1.0 for individual storms.
Rv values were taken from Figure 9, attached.
C values taken from Table 8, NURP Study Average.
A values taken from the Sawyer Brook Watershed plan and adjusted in the existing condition to reflect combined stormwater-sewer areas and subareas not included in the proposed condition.

Table 1 summarizes variables used in the analysis:

Table 1

SIMPLE METHOD VARIABLES

SubArea	% Imp.	Rv	A_{pre}	A_{post}
A	20	.22	8.63	9.96
B	40	.40	26.35	26.35
C	50	.50	15.90	15.90
D	45	.45	0	24.09
E	20	.22	20.04	20.04
F	30	.32	25.22	25.22
G	0	.05	14.16	14.16
H	5	.10	16.81	30.57
I	25	.28	5.62	7.50
J	20	.22	11.14	13.02
K	30	.32	7.89	7.89
L	40	.40	8.78	9.38
M	90	.85	14.12	16.82
N	50	.50	16.37	31.43
O	75	.74	13.83	13.83
P	65	.64	4.57	7.71
Q	75	.74	1.80	3.05
R	75	.74	7.26	7.26
S	70	.68	0	4.72
T	15	.18	5.45	9.24
U	20	.22	.48	.81
V	40	.40	.58	.98
W	40	.40	3.62	7.38
X	0	.05	12.37	12.37
Y	50	.50	0	34.65
	39.6(ave-non wt'd)		240.98	354.33

Table 2
Analysis Results of Pollutants (#) (Pre/Post)

Sub Area	COD	TSS	Pb	Zn	Cu	TKN	P(total)	BOD5
A	39.07/45.09	38.72/44.69	.08/.09	.08/.09	.02/.02	1.42/1/63	.20/.23	5.10/5.86
B	216.92	215.01	.43	.42	.11	7.91	1.10	28.43
C	163.62	162.18	.32	.32	.08	5.96	.83	21.42
D	0/223.11	0/221.15	0/.44	0/.43	0/.12	0/8.13	0/1.13	0/29.22
E	90.74	89.94	.18	.18	.05	3.31	.46	11.90
F	166.10	164.64	.33	.32	.08	6.05	.84	21.75
G	14.57	14.44	.03	.03	.01	.53	.07	1.90
H	34.59/62.91	34.29/62.36	.07/.12	.07/.12	.02/.03	1.26/2.29	.18/.32	4.58/8.23
I	32.38/43.22	32.10/42.84	.06/.08	.06/.08	.02/.03	1.18/1.58	.16/.22	4.24/5.68
J	50.44/58.95	50.00/58.43	.10/	.10/.12	.03/.11	1.84/2.15	.26/.30	6.62/7.73
K	51.96	51.50	.10	.10	.03	1.89	.26	6.79
L	72.28/77.22	71.65/76.54	.14/.15	.14/.15	.04/.04	2.63/2.82	.37/.39	9.46/10.14
M	247.01/294.25	244.84/291.66	.49/.58	.48/.57	.13/.15	9.00/10.72	1.25/1.49	32.35/38.54
N	168.45/323.43	166.97/320.59	.34/.67	.32/.63	.09/.17	6.13/11.79	.85/1.64	22.04/42.39
O	210.63	208.78	.42	.41	.11	7.68	1.07	27.61
P	60.06/101.56	59.53/100.66	.12/.20	.12/.20	.03/.05	2.19/3.70	.31/.52	7.87/13.30
Q	27.41/46.45	27.17/46.04	.05/.09	.05/.09	.01/.02	1.0/1.69	.14/.24	3.59/6.08
R	110.57	109.60	.22	.21	.06	4.03	.56	14.49
S	0/66.05	0/65.48	0/.13	0/.13	0/.03	0/2.41	0/.33	0/8.66
T	20.19/34.23	20.01/33.93	.04/.07	.04/.07	.01/.02	.74/1.25	.10/.17	2.66/4.49
U	2.17/3.67	2.15/3.64	0.0/0.01	0.0/0.01	0.0/0.0	.08/.13	.01/.02	.29/.47
V	4.77/8.07	4.73/8.00	.01/.02	.01/.02	.0/.0	.17/.29	.02/.04	.61/1.04
W	29.81/60.76	29.54/60.22	.06/.12	.06/.12	.02/.03	1.09/2.21	.15/.31	3.92/7.95
X	12.72	12.62	.02	.02	.01	.46	.06	1.65
Y	0/356.56	0/353.42	0/.70	0/.69	0/.18	0/13.00	0/1.81	0/46.73
TOTAL	**1826/2843**	**1810/2818**	**3.80/5.62**	**2.49/5.10**	**.96/1.36**	**66.55/103.51**	**9.25/14.41**	**268/373**
Increase (%)	**36**	**36**	**32**	**51**	**29**	**36**	**36**	**28**

The analysis results, Table 2, show increases in pollutant loading rates ranging from 28% to 51% from the existing condition to the improved condition. The results also predict an increase in pollutant quantity from .96 # to 1.36 # for the minimal pollutant, Copper and from 1826 # to 2843 # for the maximum pollutant, COD. It is important to understand that these results do not account for any removal of pollutants resulting from Best Management Practices and also assume that in the existing condition all combined (CSO) catchments receive 100% treatment.

An evaluation of Best Management Practices within each drainage area was accomplished from the Time of Concentration worksheets (attached) used in the Sawyer Brook Watershed Study. These worksheets, provided by the Soil Conservation Service, include cover, slope, and type of flow conditions within each drainage area. Best Management Practices (BMP's), which provide pollutant removal capabilities, differ in efficiency depending on the type of flow; sheet, shallow concentrated, or channel, the cover conditions, the flow length, and the flow slope. Roughness coefficients, or Manning's "n" values for different cover conditions are provided by the worksheets. The Manning's "n" value for sheet flow conditions within most drainage areas was .24, corresponding to dense grass cover conditions. Drainage Areas; H, I, J, K, L, W, and X were exceptions and an n value of .4, relating to light underbrush cover conditions, was used. Additionally, all drainage areas contained a shallow concentrated flow condition in which an n value of .16, relating to residue cover conditions, was used. Most drainage areas also contained a small tributary section in which n values of .24 and .21 were used.

BMP evaluation included sheet flow conditions, modeled as a filter strip, and shallow concentrated flow conditions, modeled as a grassed swale. These two BMP's are recognized as providing the following pollutant removal rates:

	COD/BOD	TSS	Pb/Zn/Cu	TKN	P
Filter Strip	0%-20%	20%-40%	20%-40%	0%-20%	0%-20%
Grassed Swale	20%-40%	20%-40%	0%-20%	20%-40%	20%-40%
Total Ave.	40%	60%	40%	40%	40%

Because these BMP's are arranged in a "Treatment Train" condition, the grassed swale is downstream of the filter strip, pollutant removal rates are cumulative. Flowing surface water containing pollutants will be treated primarily by the filter strip and receive additional treatment from the swale.

Based on the average removal efficiency rates pollutant loading after treatment is estimated as follows for the existing (predeveloped) and improved (postdeveloped) conditions.

Pollutant	Predeveloped (#)	Postdeveloped (#)
COD	1095	1705
BOD	161	224
TSS	724	1690
Pb	2.3	3.4
Zn	1.5	3.1
Cu	0.6	0.8
TKN	40	62
P	6	9

Concentrations of COD, BOD, and TSS appear to be substantial. However, COD and BOD predictions are consistent with other analyses for watersheds similar in size and development conditions. The applicability of TSS prediction using the Simple Method equation is also suspect to validity of accuracy.

The results of this analysis differ substantially from a previous analysis conducted by this office and dated December 13, 1994. This analysis utilized a 1" storm event routed through each drainage area to determine stormwater runoff quantities. Results were based on the acceptance in engineering practice that a majority of pollutants are present in the "first flush" of stormwater, equal to the first 1" of rainfall, or the first 1/2" of runoff. Because, this analysis determined that only minimal amounts of runoff would be generated from the 1" storm event, pollutant export would be minimal. Most rainfall would be infiltrated and treated by the soil profile within each drainage area. The Simple Method accounts for a percentage of impervious area within each study area but does not account for hydrologic soil groups, or infiltration characteristics outside of the impervious areas. Therefore, results of both studies, and the inconsistencies between the two, should be considered in predicting pollutant export in the Sawyer Brook Watershed.

Sincerely;

Kenneth A. Wood, P.E.
District Engineer

TABLE 9. Uncontrolled Nonpoint Pollution Loading Rates (lbs/acre/year)

LAND USE	Density DU / Acre	Percent Imperviousness*	BOD SOILS Clay Loam Silt Loam Loam ★	BOD SOILS Sandy Loam ○	TP SOILS Clay Loam Silt Loam Loam	TP SOILS Sandy Loam	TN SOILS Clay Loam Silt Loam Loam	TN SOILS Sandy Loam
I. Undeveloped Forest		1%	7	6	0.1	0.1	2.5	2.4
Abandoned Farm Land		1%	8	6	0.2	0.1	3.0	2.6
Cropland								
A. Conventional Tillage		1%	45	29	4.2	2.3	18.6	12.5
B. Minimum Tillage		1%	22	19	1.5	1.1	9.6	8.7
Cow Pasture		1%	32	13	0.5	0.3	6.2	4.3
II. Developed								
A. Residential Categories								
	0.5	9%	22	13	0.8	0.5	6.1	5.1
Large-Lot	1.0	12%	23	14	0.8	0.6	6.6	5.7
Single Family	2.0	18%	25	17	0.9	0.7	7.5	6.7
	3.0	20%	27	18	1.0	0.8	8.0	7.1
Medium	4.0	25%	28	20	1.1	0.9	8.8	7.9
Density Single Family	5.0-6.0	35%	32	25	1.3	1.1	10.4	9.7
	6	35%	35	26	1.5	1.2	11.7	9.9
Townhouse/	8-10	40%	40	32	1.6	1.5	12.4	10.8
Garden Apt.	10-20	50%	50	36	1.8	1.7	13.9	12.5
High-Rise	30%	60%	113	111	1.2	1.2	10.1	10.1
	30%	75%	138	137	1.4	1.4	11.6	11.6
B. Commercial/ Industrial								
Industrial		(Medium) 60%	113	111	1.2	1.2	10.1	10.1
		(High) 80%	146	145	1.5	1.4	12.2	12.2
Suburban Shopping Ctr.		90%	163	163	1.6	1.6	13.2	13.2
Central Business Dist.		95%	206	206	2.7	2.7	24.6	24.7

Source: Regional Resources Division, Northern Virginia Planning District Commission. Guidebook for Screening Urban Nonpoint Pollution Management Practices. (Prepared for Metropolitan Washington Council of Governments) November, 1979.

• Rooftop areas are not included in the percent imperviousness for large lot and medium density single family uses.

★ Hydrologic Soil Group C or D

Hydrologic Soil Group A or B

Table 8: Urban 'C' Values For Use With the Simple Method (mg/l)

POLLUTANT	NEW SUBURBAN NURP SITES (Wash., DC)	OLDER URBAN AREAS (Baltimore)	CENTRAL BUSINESS DISTRICT (Wash., DC)	NATIONAL NURP STUDY AVERAGE	HARDWOOD FOREST (Northern Virginia)	NATIONAL URBAN HIGHWAY RUNOFF
PHOSPHORUS						
Total	0.26	1.08	-	0.46	0.15	-
Ortho	0.12	0.26	1.01	-	0.02	-
Soluble	0.16	-	-	0.16	0.04	0.59
Organic	0.10	0.82	-	0.13	0.11	-
NITROGEN						
Total	2.00	13.6	2.17	3.31	0.78	-
Nitrate	0.48	8.9	0.84	0.96	0.17	-
Ammonia	0.26	1.1	-	-	0.07	-
Organic	1.25	-	-	-	0.54	-
TKN	1.51	7.2	1.49	2.35	0.61	2.72
COD	35.6	163.0	-	90.8	>40.0	124.0
BOD (5-day)	5.1	-	36.0	11.9	-	-
METALS						
Zinc	0.037	0.397	0.250	0.176	-	0.380
Lead	0.018	0.389	0.370	0.180	-	0.550
Copper	-	0.105	-	0.047	-	-